

# **Marine Aviation Equipment and Systems**



**U.S. Marine Corps**

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DEPARTMENT OF THE NAVY  
Headquarters United States Marine Corps  
Washington, DC 20380-0001

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FOREWORD

1. PURPOSE

Fleet Marine Force Reference Publication (FMFRP) 5-85, *Marine Aviation Equipment and Systems*, provides general information on U.S. Marine Corps Fleet Marine Force aviation aircraft and equipment. Changes in equipment which occur after this publication will appear in subsequent updates.

2. SCOPE

This reference publication provides information for Marines at all levels on aircraft and aviation weapons. The appendixes provide location of aviation units, squadron designations, delivery maneuvers, and helicopter characteristics.

3. SUPERSESSSION

None.

4. CHANGES

Recommendations for improving this manual are invited from commands as well as directly from individuals. Forward suggestions using the User Suggestion Form format to—

Commanding General  
Doctrine Division (C 42)  
Marine Corps Combat Development Command  
2042 Broadway Street Suite 210  
Quantico, VA 22134-5021

5. CERTIFICATION

Reviewed and approved this date.

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS



M. P. CAULFIELD  
Major General, U.S. Marine Corps  
Deputy Commander for Warfighting  
Marine Corps Combat Development Command  
Quantico, Virginia

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## User Suggestion Form

From:

To: Commanding General, Doctrine Division (C 42), Marine Corps Combat Development Command, 2042 Broadway Street Suite 210, Quantico, Virginia 22134-5021

Subj: RECOMMENDATIONS CONCERNING FMFRP 5-85, *MARINE AVIATION EQUIPMENT AND SYSTEMS*

1. In accordance with the foreword to FMFRP 5-85, which invites individuals to submit suggestions concerning this FMFM directly to the above addressee, the following unclassified recommendation is forwarded:

Page	Article/Paragraph No.	Line No.	Figure/Table No.
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2. Proposed new verbatim text: (Verbatim, double-spaced; continue on additional pages as necessary.)

3. Justification/source: (Need not be double-spaced.)

Note: Only one recommendation per page.

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## Record of Changes

Change No.	Date of Change	Date of Entry	Organization	Signature

# Marine Aviation Equipment and Systems

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# Chapter 1

## Fleet Marine Force Aircraft

### 1001. Fixed-Wing Attack

Fixed-wing attack aircraft provides offensive air support (OAS) for the Marine Air-Ground Task Force (MAGTF). OAS operations deliver firepower against enemy installations, facilities, and personnel. The MAGTF commander uses OAS to achieve his objectives by destroying enemy resources and isolating the enemy's military force.

**a. AV-8B.** The AV-8B (see fig. 1-1) is a single-seat, transonic, vectored-thrust, light attack aircraft. Marine attack squadrons (VMAs) use the

AV-8B. The AV-8B is a follow-on version of the earlier AV-8A/C models. The AV-8B has the GAU-12 25mm gun system and can carry up to 9,200 pounds of external ordnance. Its V/STOL capability provides increased responsiveness to MAGTF commander's OAS requirements through basing flexibility and high sortie rates. The angle rate bombing system (ARBS) allows accurate first pass attacks and high kill probability using laser spot or TV tracking. The aircraft has an inertial navigation system. Introduction of the AV-8B Night Attack began in October 1989. Its forward looking infrared (FLIR) system, night vision goggles (NVG) compatible cockpit lighting, and

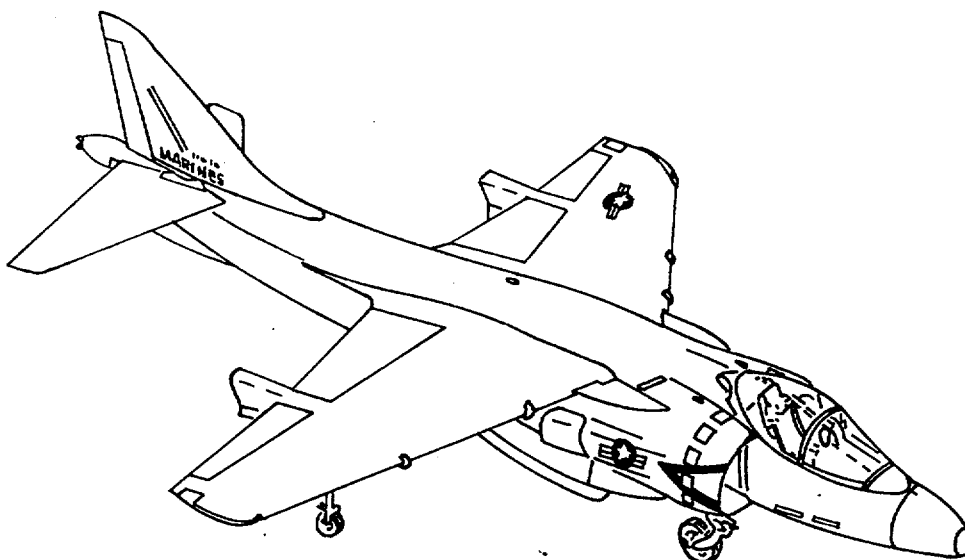


Figure 1-1. AV-8B – Harrier.

moving map display allow ground attacks at night under the weather. Some aircraft will receive the F/A-18 APG-65 radar for improved air-to-air and air-to-ground capability.

**b. A-6E.** The A-6E (see fig. 1-2) is a twin-engine, two-place, all weather medium attack aircraft. Marine attack (all weather) squadrons (VMA(AW)s) use the A-6E. The Marine Corps flies A-6Es equipped with target recognition and attack multisensor (TRAM) equipment. The A-6E can navigate, locate, track, and attack stationary and moving targets without visual reference to the ground or the target. The TRAM has a laser designator and a FLIR detector. Additional all weather OAS is available using the ground-based, radar beacon forward air controller (RABFAC). This equipment allows a ground forward air controller to identify nonradar significant targets to the A-6. The A-6 delivers conventional ordnance and nuclear weapons in all weather conditions. The F/A-18D is replacing the A-6E.

and maintain air superiority. Air superiority provides dominance over the battlefield. It allows the MAGTF to conduct ground and air operations without interference from enemy air action. Air superiority enhances MAGTF capabilities.

**a. F-4S.** The F-4S (see fig. 1-3) is a supersonic, two-place, twin-engine, all weather fighter attack aircraft. Reserve Marine fighter attack squadrons (VMFAs) use the F-4S.

**b. F/A-18.** The F/A-18 (see fig. 1-4) is a single-place, twin-engine, strike fighter. The F/A-18 began to replace the F-4 in 1983. The F/A-18 can intercept enemy aircraft and perform ground attack. It has an internal 20mm M-61 gun and can carry over 17,000 pounds of ordnance. The F/A-18D (see fig. 1-5) is the two-seat variant of the F/A-18. VMFA(AW)s will use the F/A-18D. A FLIR system, NVG compatible cockpit lighting, and digital moving map display enable the F/A-18C (procured after FY 90)/D to perform ground attacks at night under the weather. Some F/A-18D aircraft will carry the advanced tactical airborne reconnaissance system (ATARS). This aircraft is replacing the A-6E for all weather attack, the RF-4 for multisensor imagery reconnaissance, and the OA-4 for tactical air control. Full replacement will be complete in FY 95.

## 1002. Fixed-Wing Fighter

Fixed-wing fighter aircraft performs antiair warfare (AAW) for the MAGTF. The MAGTF uses AAW to destroy or reduce enemy air and missile threats. The primary purpose of fighter aircraft is to gain

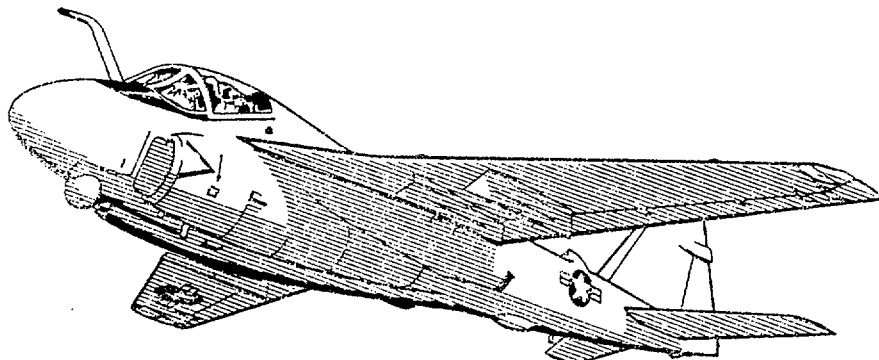


Figure 1-2. A-6—Intruder.

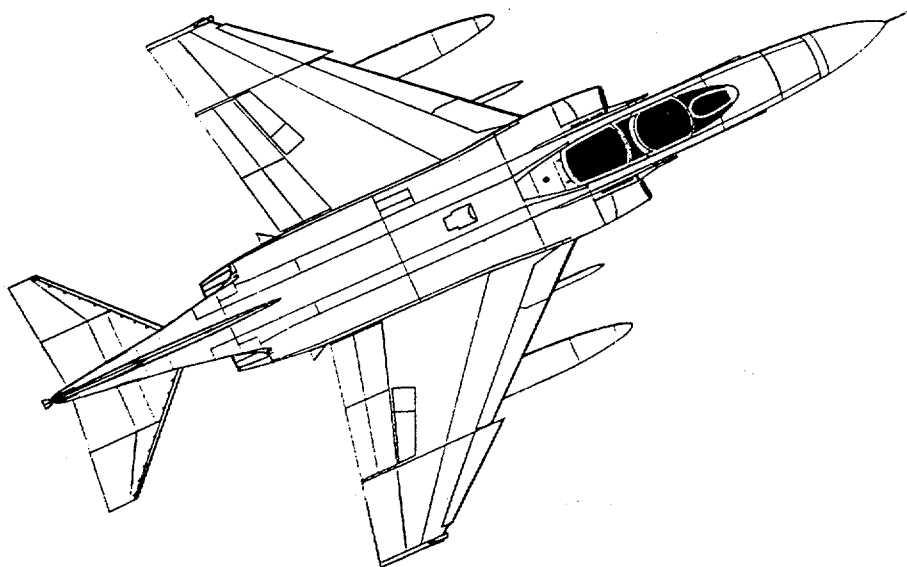


Figure 1-3. F-4S – Phantom.

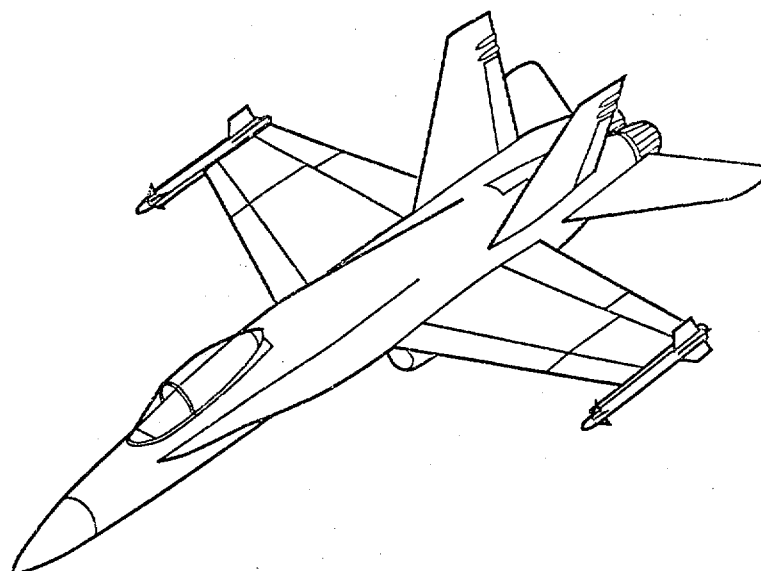


Figure 1-4. F/A-18 – Hornet.



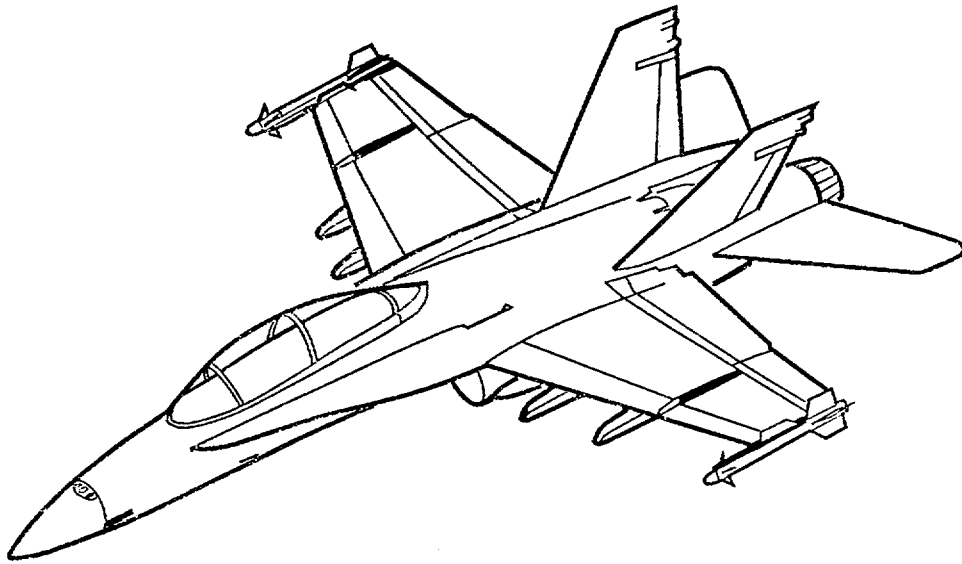


Figure 1-5. F/A-18D – Hornet.

### 1003. Fixed-Wing Electronic Warfare

The EA-6B (see fig. 1-6) is a four-place (one pilot and three electronic countermeasures officers), twin-engine, subsonic electronic warfare aircraft. Marine Tactical Electronic Warfare Squadron-Two (VMAQ-2) uses the EA-6B. The EA-6B supports the MAGTF by suppressing enemy electronic activity

and by gaining tactical electronic intelligence. The aircraft can carry up to five integrally powered pods for jamming early warning, acquisition, and fire control radars. The aircraft detects, analyzes, and records signals for post mission evaluation. Improvements to the advanced capabilities EA-6B will ensure the aircraft can continue to be effective through 2010.

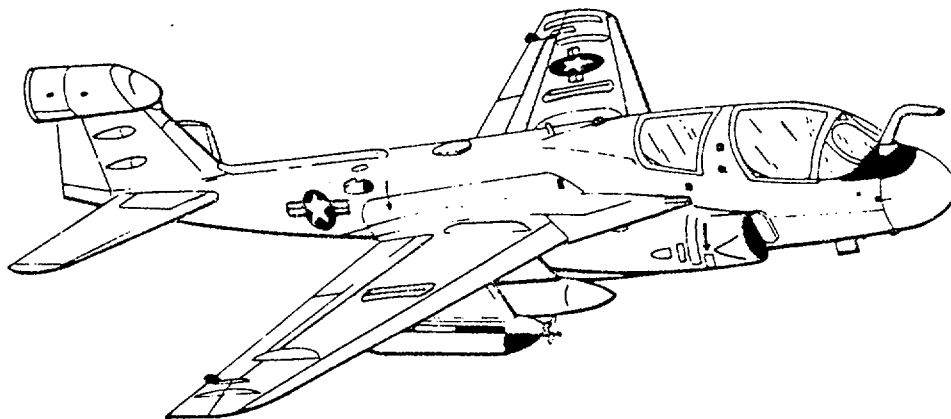


Figure 1-6. EA-6B – Prowler.

#### 1004. Fixed-Wing Observation

The OV-10A (see fig. 1-7) is a twin-turboprop, two-place, short takeoff and landing aircraft. Marine observation squadrons (VMOs) use the OV-10. The OV-10 can conduct aerial reconnaissance, observation, and supporting arms coordination during both day and night operations in support of the MAGTF. The OV-10 can also provide fire support for the MAGTF. To reduce maintenance and logistics requirements, improve operational capability, and extend the aircraft's service life, the OV-10A will undergo a service life extension program (SLEP). When completed, the OV-10D will have upgraded engines, a FLIR sensor, and a laser rangefinder/designator (LRD).

#### 1005. Fixed-Wing Transport

The KC-130F/R/T (see fig. 1-8) is a four-engine, turboprop, aerial refueler and assault transport aircraft. Marine aerial refueler transport squadrons (VMGRs) use the KC-130. The KC-130 provides the MAGTF commander a self-deployable, multimission aircraft. The KC-130 can aerial refuel aircraft equipped with refueling probes, and they can ground refuel

helicopters and AV-8s at austere landing sites. Additional tasks include aerial delivery of troops and cargo, and operation of an airborne direct air support center. As a tactical transport, the KC-130 can carry 92 troops, 64 paratroops, 74 litters, or 35,000 pounds of cargo.

#### 1006. Helicopter Attack

The AH-1 is a multimission, tandem-seat, two-place (pilot and gunner/copilot), twin-engine, attack helicopter. Marine light attack helicopter squadrons (HML/A) use the AH-1. The first AH-1, the AH-1J, entered service in 1968. A major limitation of the AH-1J is its lack of a precision antiarmor weapons capability. This shortfall resulted in the production of the AH-1T. This aircraft features improved engines and the TOW (tube launched, optically tracked, wire command link, guided missile system). The AH-1J and T can use the AIM-9 Sidewinder and AGM-122A Sidearm I. The newest Marine AH-1, the AH-1W (see fig. 1-9), can provide the MAGTF commander with a significant force multiplier in offensive and defensive operations. This aircraft is replacing both the AH-1J and AH-1T. Improvements to the AH-1W include NVG

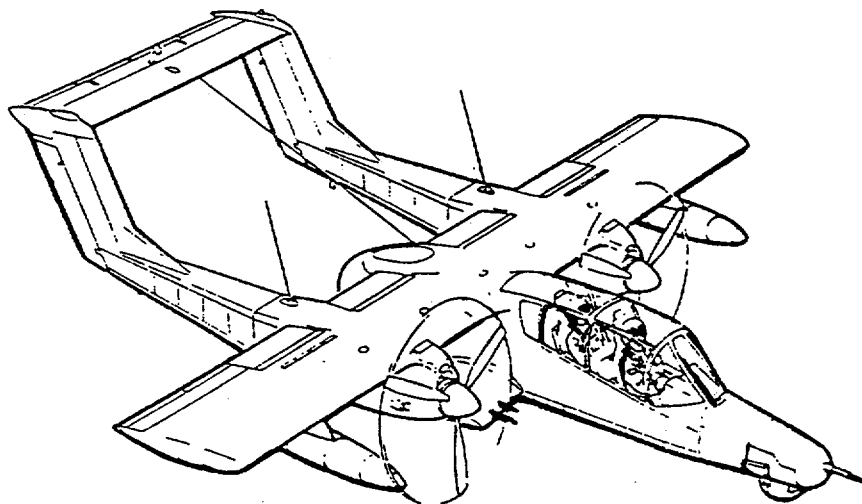


Figure 1-7. OV-10D – Bronco.

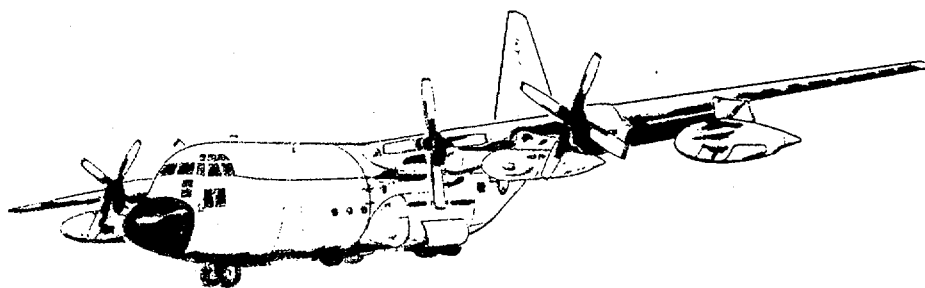


Figure 1-8. KC-130 – Hercules.

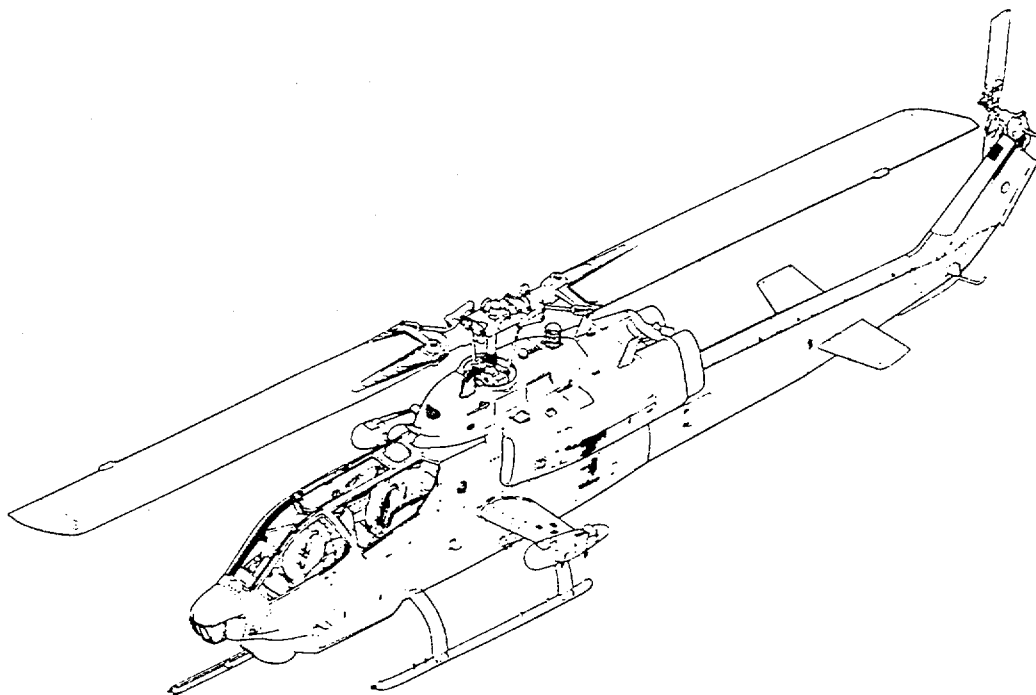


Figure 1-9. AH-1W – Cobra.

compatible cockpit, head-up display, and crashworthy fuel system. The AH-1W's two GE T-700 engines provide a quantum improvement in high/hot capabilities. The AH-1W can use the TOW and Hellfire missiles, the Sidewinder, and the Sidearm I. Future improvements to the AH-1W include a doppler navigation system, a night targeting system (FLIR, automatic target tracker, LRD), and video recorder.

### 1007. Helicopter Utility

The UH-1N (see fig. 1-10) is a twin-engine, two-seat, single-piloted, single-rotor, utility helicopter.

HML/A squadrons use the UH-1N. The mission of the UH-1N is to provide combat utility support for the MAGTF. It can transport a maximum of 13 passengers or provide airborne command and control using the ASC-26 communications package. The aircraft can aid local search and rescue assets and provide aeromedical evacuation of casualties. The UH-1N can conduct offensive operations against enemy ground forces. The UH-1N can carry two 7.62mm GAU-17 or M-60 machine guns and a defensive armament system. This system allows the UH-1N to use 2.75-inch rockets, crew-served .50 caliber machine guns, and fixed forward and crew-served 7.62mm machine guns.

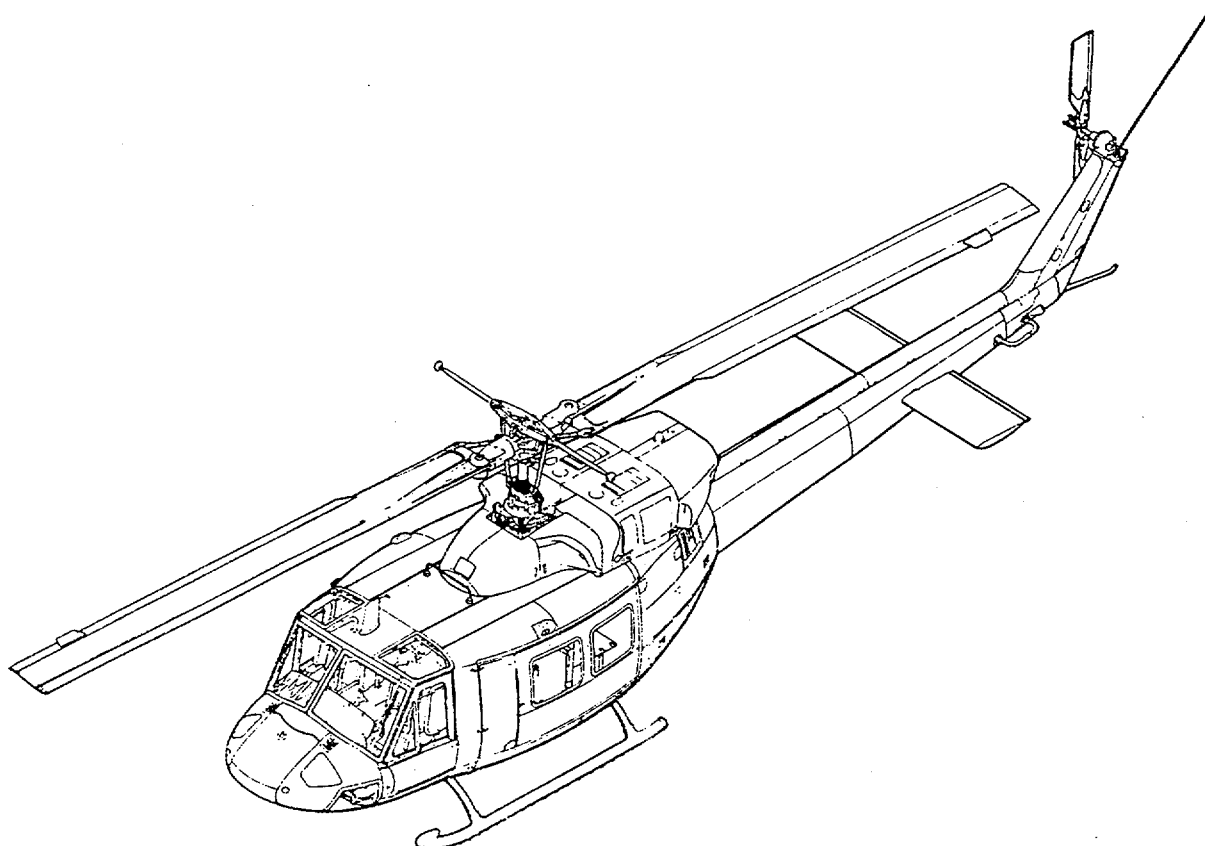


Figure 1-10. UH-1N – Huey.

## 1008. Helicopter Transport

Transport helicopters, medium and heavy, provide assault support for the MAGTF. Assault support operations provide air transportation of personnel, supplies, and equipment into or within the area of operations. These operations are tactical, administrative, or logistical in nature. The MAGTF uses assault support of troops by transport helicopter in all types of combat operation. Assault support helicopter operations include vertical assault, aerial delivery, air evacuation, tactical recovery of aircraft and personnel (TRAP), and battlefield illumination.

**a. CH-46E.** The CH-46E (see fig. 1-11) is a dual-piloted, twin-engine, tandem rotor assault support helicopter. Marine medium helicopter squadrons (HMMs) use the CH-46E. The primary mission of

the CH-46 is to provide assault transport of combat troops. The cabin section has provisions for 25 personnel. Normal configuration is for 15 combat-loaded troops. The CH-46 can transport supplies and equipment (internally and externally) and provide medical evacuation for 15 litter patients. The CH-46 can mount two 7.62 M-60 machine guns or two .50 caliber XM-218 machine guns for self-protection. The CH-46E has the following features:

- Crash attenuating pilot seats
- Exhaust infrared suppressors
- Crashworthy fuel system

The CH-46E is undergoing a block upgrade. This will include the installation of extended range fuel tanks, flotation equipment, and precision navigation.



Figure 1-11. CH-46E—Sea Knight.

**b. CH-53D.** The CH-53D (see fig. 1-12) is a dual-piloted, twin-engine, single-rotor assault support helicopter. Marine heavy helicopter squadrons (HMHs) use the CH-53. The primary mission of the CH-53 is to provide helicopter transport of supplies and equipment. The cabin contains cargo winches, roller conveyors, and tiedown fittings. The external cargo hook allows the movement of large or out-sized cargo. The CH-53 can also transport up to 55 personnel. Normal configuration is 30 combat-loaded troops. The aircraft can carry 24 litters during medical evacuation operations. The CH-53D can mount two 7.62 M-60 machine guns or two .50 caliber XM-218 machine guns for self-protection.

**c. CH-53E.** The CH-53E (see fig. 1-13) is a growth variant of the CH-53D. It is a dual-piloted, single-rotor helicopter with three engines. The CH-53E is the free world's largest helicopter and can transport 16 tons over a mission radius of 50 nautical miles. The CH-53E can lift 93 percent of a Marine division's equipment. While doubling the lift capability of the CH-53D, the CH-53E requires only 10 percent more deck space than a CH-53D with tip tanks. Mission features include—

- Utility hoist
- Dual hook external capability

- External auxiliary fuel tanks
- In-flight refueling
- Machine gun armament

The secondary mission of the CH-53E is passenger transport. Use CH-53D planning figures for troop capacity.

### 1009. Primary Aircraft Authorization

SQUADRON	AIRCRAFT	PAA
VMFA	F/A-18	12
VMFA(AW)	F/A-18D	12
VMA	AV-8B	20
VMA(AW)	A-6E	10
VMAQ-2	EA-6B	18
VMGR	KC-130F/R/T	12
HMH	CH-53D	12
HMH	CH-53E	16
HMM	CH-46E	12
HML/A *	AH-1W	12
	UH-1N	12
VMO	OV-10A/D	12

\* HML/A will transition to a PAA of 18 AH-1W and 9 UH-1N beginning in FY-95.

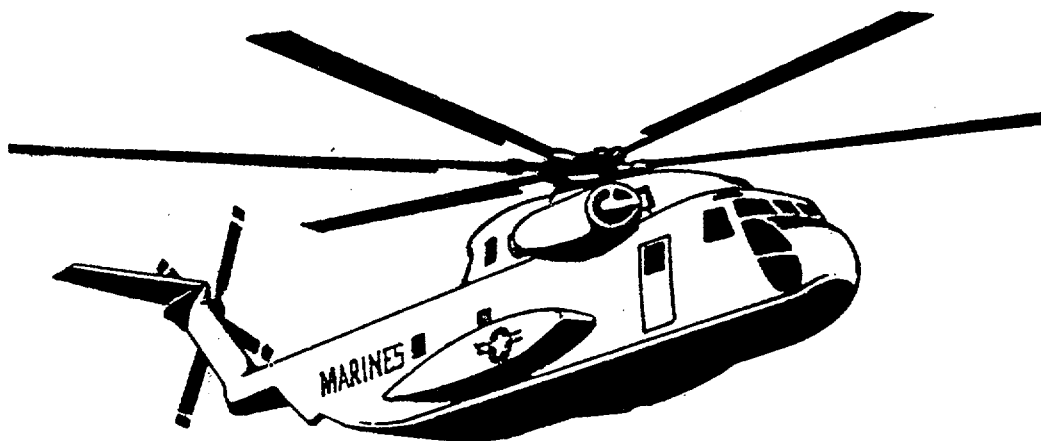
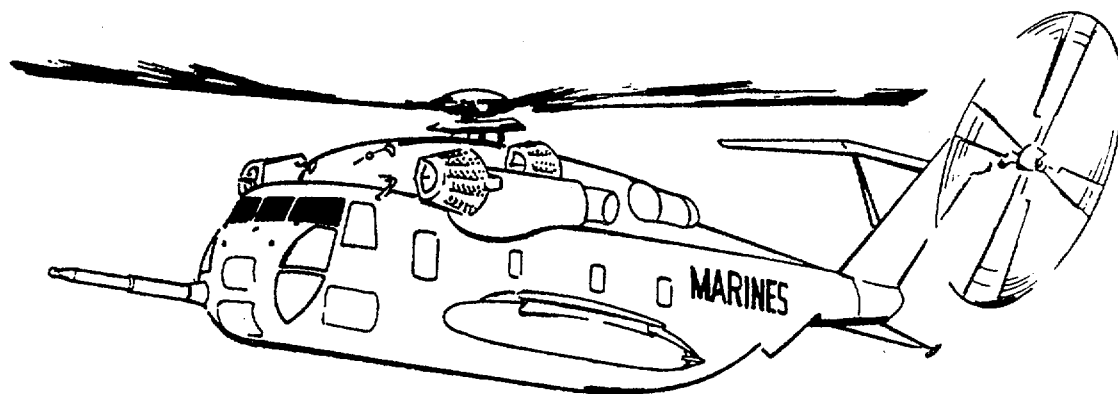


Figure 1-12. CH-53D – Sea Stallion.



**Figure 1-13. CH-53E – Super Stallion.**

## Chapter 2

# Aircraft Ordnance

Marine aviation uses a variety of aircraft weapons and associated systems. The type weapon or system will depend on the mission, method of delivery, and desired results. To exploit the full capability of any weapon or system, we must understand some basic nomenclature and what weapon options are available. See FMFM 4-7, FMFRP 6-14, FMFM 5-2, and the FMFRP 10 series, (C) Joint Munitions Effectiveness Manuals (JMEM) (U), for complete weapons listings, descriptions, and kill probability tables.

### 2001. General Purpose, High Explosive Bombs

**a. MK-80 Series Bombs.** General purpose, low-drag, MK-80 series bombs (see fig. 2-1) are one of the most widely used weapons in the inventory. Specific weight classes and designations are:

DESIGNATION	WEIGHT CLASS
MK-81	* 250 pounds
MK-82	500 pounds
MK-83	1,000 pounds
MK-84	2,000 pounds

\* No longer bought

MK-80 series bombs can use conical, retarding, or tail stabilizer fins. About 45 to 50 percent of the bomb weight is the explosive. When fuzed for instantaneous detonation, they provide good fragmentation effects against personnel and light equipment. New production bombs have a thermal protective coating. This coating provides several minutes additional time before the bombs detonate or deflagrate (go low-order) during a fire.

The advanced bomb family (ABF) will eventually replace the MK-80 series bombs. The ABF will consist of two weight classes. The 500-pound class will be used for fragmentation/blast sensitive targets, and the 1,000-pound class for penetration. The ABF will improve delivery accuracy and performance at detonation.

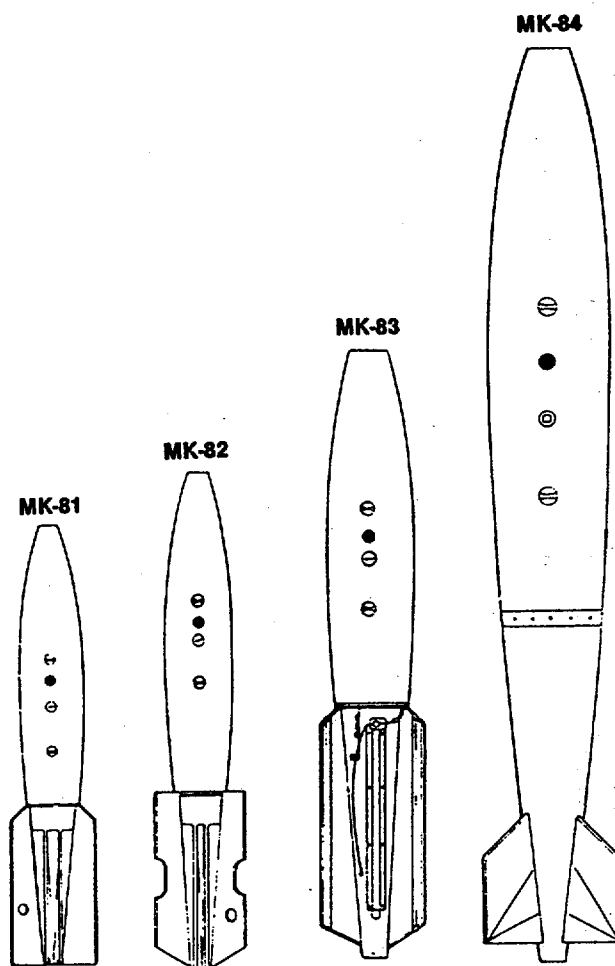
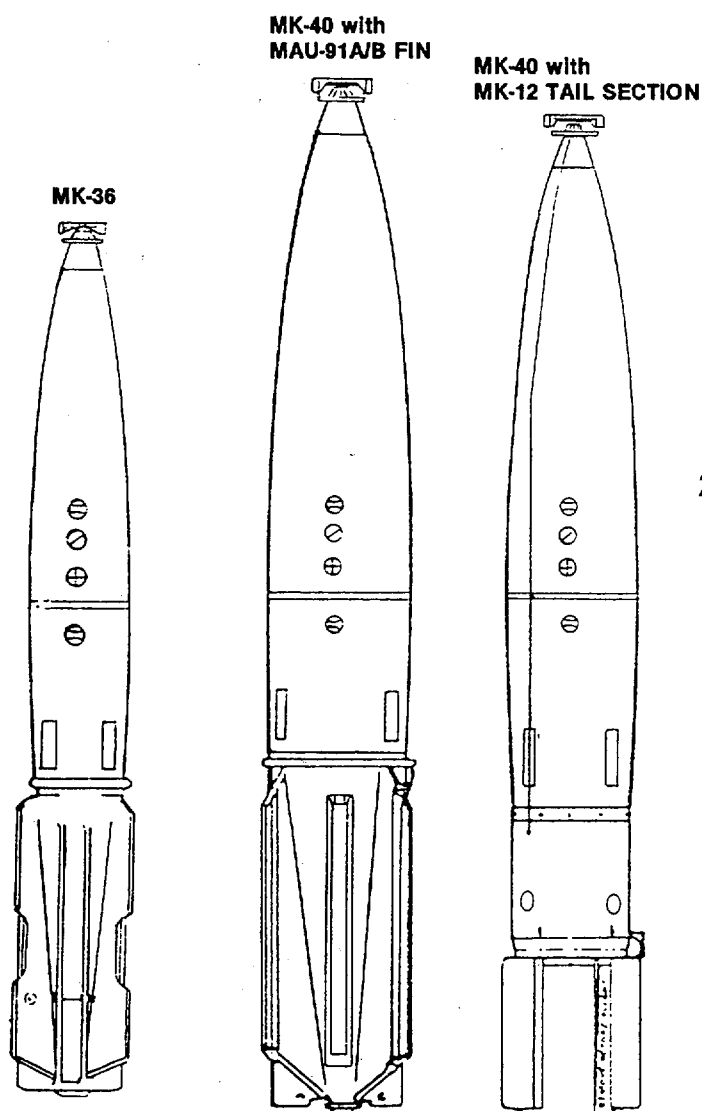


Figure 2-1. MK-80 Series GP Bombs.



**b. Destructors.** MK-36, MK-40, and MK-41 destructors (see fig. 2-2) use magnetic or magnetic-seismic influences from the target to cause detonation. The ballistics and blast effect of the MK-36 is the same as an MK-82 bomb, the MK-40 the same as an MK-83, and the MK-41 the same as an MK-84.



**Figure 2-2. MK-36, MK-40, and MK-41 Destructors.**

### c. Tail Assemblies

**(1) Conical Fins.** The conical tail fin (see fig. 2-3) is used on all MK-80 series bombs for a free fall, unretarded, unguided flight for the weapon.

**(2) Snakeye Fins.** The snakeye fin (see fig. 2-4) is a retarding device for use on MK-81 and MK-82 bombs. The bomb can be dropped unretarded, acting like a conically finned bomb. When the snakeye fins are open, they act against the bombs' inertia. This allows aircraft to use low altitude delivery procedures while remaining out of the bomb fragmentation pattern. The MK-83 bomb cannot use snakeye fins. It can use an air inflatable retarding parachute assembly which acts like the snakeye fins.

**(3) Tail Stabilizer Fins.** The tail stabilizer fins are for use on guided bomb units (GBUs). Paragraph 2002 describes GBUs in detail.

## 2002. Guided Bombs

**a. Guided Bomb Units.** GBUs are MK-82, MK-83, or MK-84 bombs which can detect a target illuminated by a laser beam. The bombs consist of the bomb body and a guidance kit. The guidance kit contains a computer control group (CCG) and an airfoil group (wing assembly and guidance fins). The CCG and guidance fins are on a forward adapter assembly at the front of the bomb to provide target detection and weapon guidance. The tail stabilizer fins are at the rear on the bomb and extend upon release from the aircraft. The guidance fins attach to the CCG to control direction of flight of the weapon. The bombs are designated GBU-12, GBU-16, and GBU-10 (see fig. 2-5).

**b. Walleye Weapon System.** The Walleye weapon system (see fig. 2-6) is an air-to-surface glide bomb. It uses automatic video tracking for homing and guidance to surface targets. Use Walleye for day visual meteorological condition (VMC) attacks.

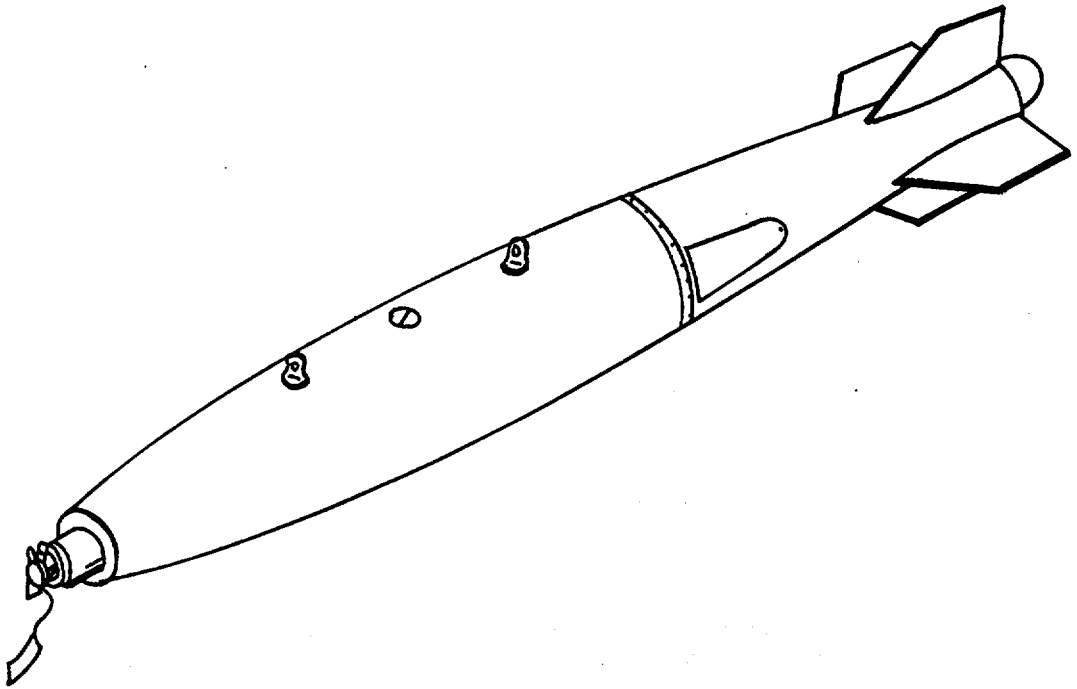


Figure 2-3. General Purpose Bomb, Conical Tail.

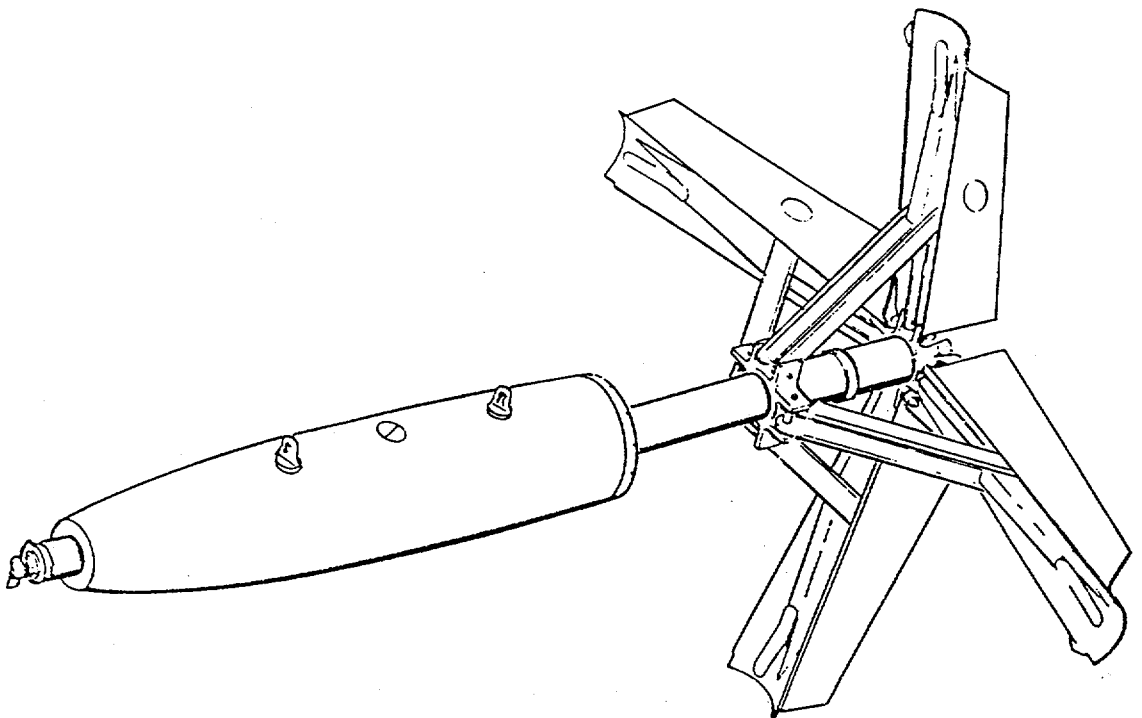
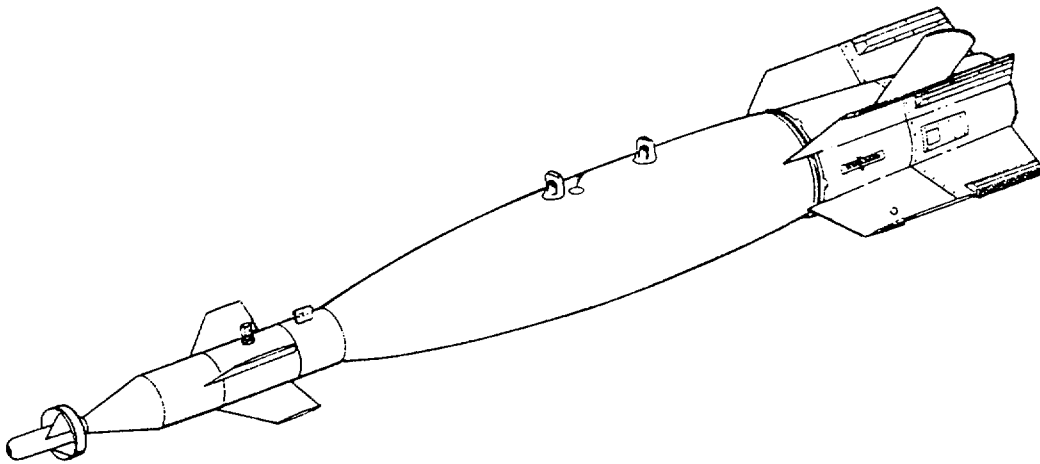


Figure 2-4. General Purpose Bomb, Snakeeye.

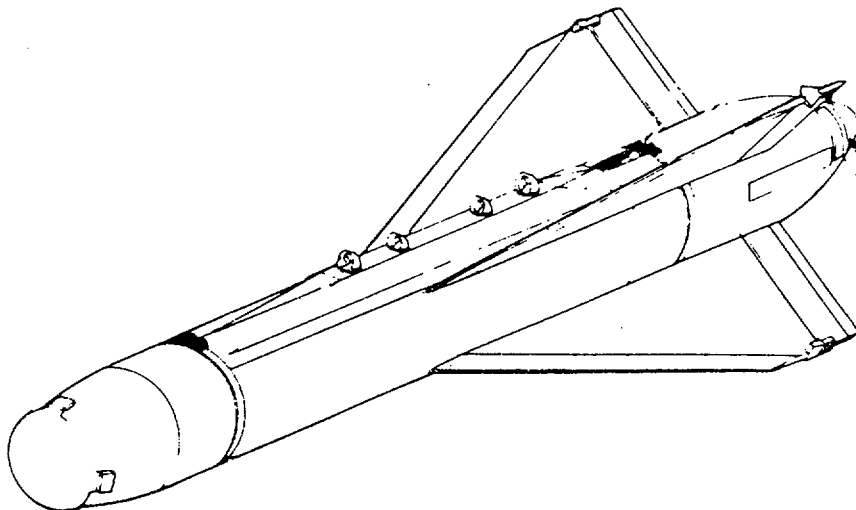


**Figure 2-5. Guided Bomb Units.**

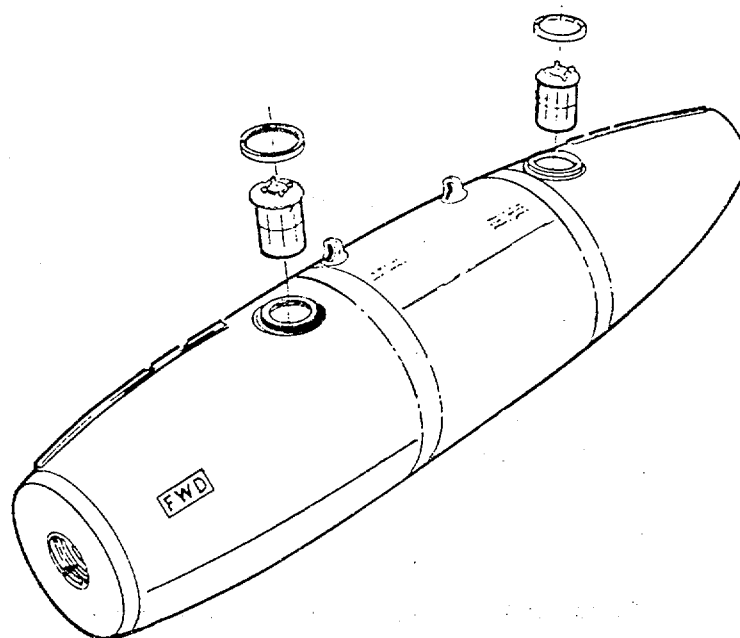
Walleye provides the attack aircraft with standoff capability for destroying defended targets while remaining outside the lethal range of most anti-aircraft artillery defenses. Walleye weapon series consist of the MK-1, MK-4, MK-21, and MK-27.

### **2003. Fire Bombs**

The MK-77 is the primary fire bomb (see fig. 2-7). It has a fuel capacity of 75 gallons and weighs 520 pounds. Fire bombs have a very erratic trajectory.



**Figure 2-6. Walleye Weapon System.**



**Figure 2-7. MK-77 Firebomb (NAPALM).**

Release the MK-77 at low altitude to achieve the desired accuracy. A typical ground pattern for the MK-77 is elliptical in shape and about 215 feet long in the direction of delivery and 75 feet wide.

#### **2004. Fuel Air Explosive**

The fuel air explosive (FAE) weapon is a free-fall, unguided weapon. An FAE contains three major parts, a dispenser, dispenser fuze, and three FAE bombs (see fig. 2-8). The FAE is effective against personnel, light materiel targets, mines, boobytraps, and for clearing landing zones. The explosive force of each FAE bomb comes from the detonation of the fuel which forms an aerosol cloud on impact. When detonated, the resulting overpressure produces target destruction. The bombs are parachute-retarded and can penetrate light foliage without detonation. The total weight of the weapon is only 520 pounds, but the explosive overpressure of each FAE bomb is equal to an MK-82.

**a. CBU-55A/B.** The CBU-55A/B FAE weapon is for use on low-speed aircraft such as the AH-1 and OV-10.

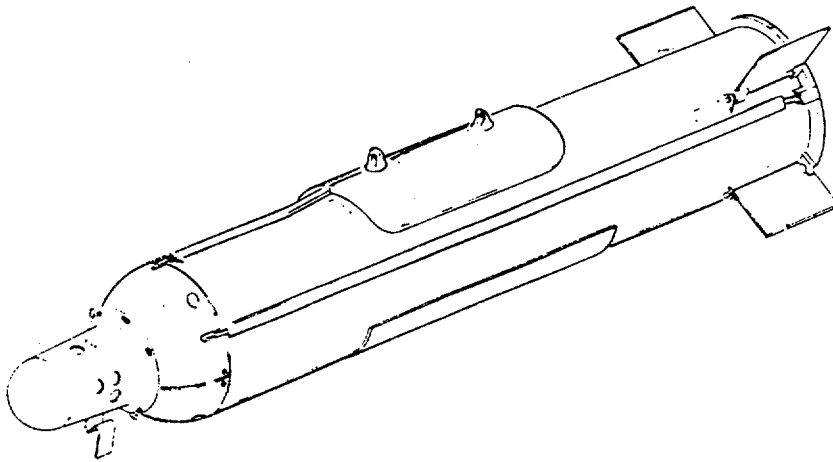
**b. CBU-72/B.** The CBU-72/B FAE weapon is for use on high-speed aircraft such as the F/A-18, A-6, and the AV-8B.

#### **2005. Cluster Bomb Unit Weapon Dispenser Systems**

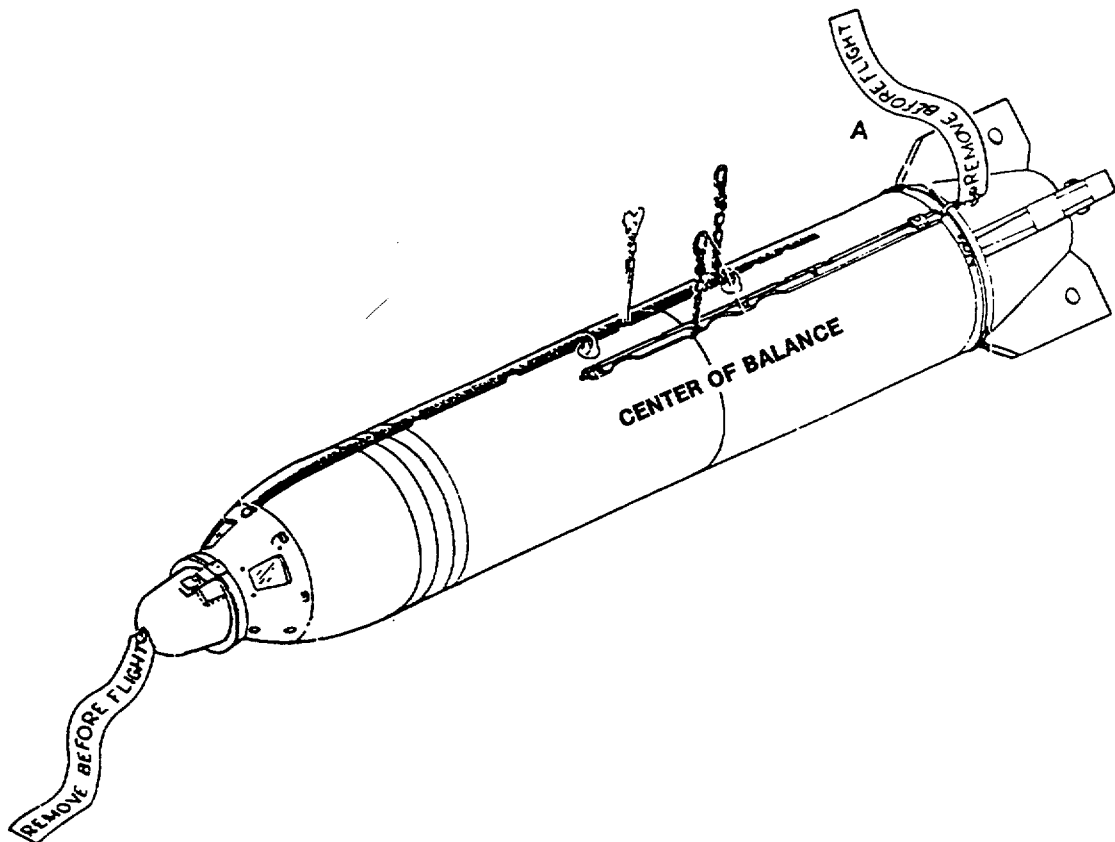
Cluster bomb unit (CBU) weapon dispenser systems consist of a bomb casing filled with many smaller munitions. These munitions include antipersonnel, antimateriel, and antitank weapons. The CBU systems provide high kill or damage probability against area, moving, and point targets.

**a. MK-20 Rockeye II.** Rockeye II (see fig. 2-9) is a dispenser/cluster bomb weapon for use against area targets. It is effective against trucks, radar vans, missile sites, fuel storage tanks, and surface ships.

Rockeye II consists of a dispenser, a mechanical time fuze which opens the dispenser at a selected time, and 247 MK-118 bomblets.



**Figure 2-8. Cluster Bomb Unit FAE Weapon.**



**Figure 2-9. Rocket II.**

The MK-118 bomblet has a small shaped-charge warhead that can penetrate six inches of armor plate. The nose fuze detonates the bomblet instantaneously to increase the shaped-charge effect on hard targets (steel or concrete). The tail fuze, which arms the bomblet after release from the dispenser, detonates the bomblet shortly after impact with softer targets. A discriminating feature of the fuze permits the bomblet to penetrate light material (vegetation, camouflage nets, light plywood) without detonating. Rockeye bomblets are heavier and penetrate thicker armor than those in the antipersonnel/antimateriel (APAM) weapon, but lack the popup feature for best antipersonnel effects.

**b. CBU-59/B APAM.** The CBU-59/B (see fig. 2-10) is an APAM cluster weapon which is highly effective against both personnel and lightly armored equipment under a wide variety of terrain conditions.

The major parts of the APAM weapon are the dispenser, the dispenser fuze, and 717 BLU-77/B bomblets. The APAM dispenser has a black three-bar lightning bolt insignia painted on each side of the case.

The BLU-77/B bomblet uses a shaped-charge warhead to penetrate the armor of light and medium tanks, surface warships, armored personnel carriers,

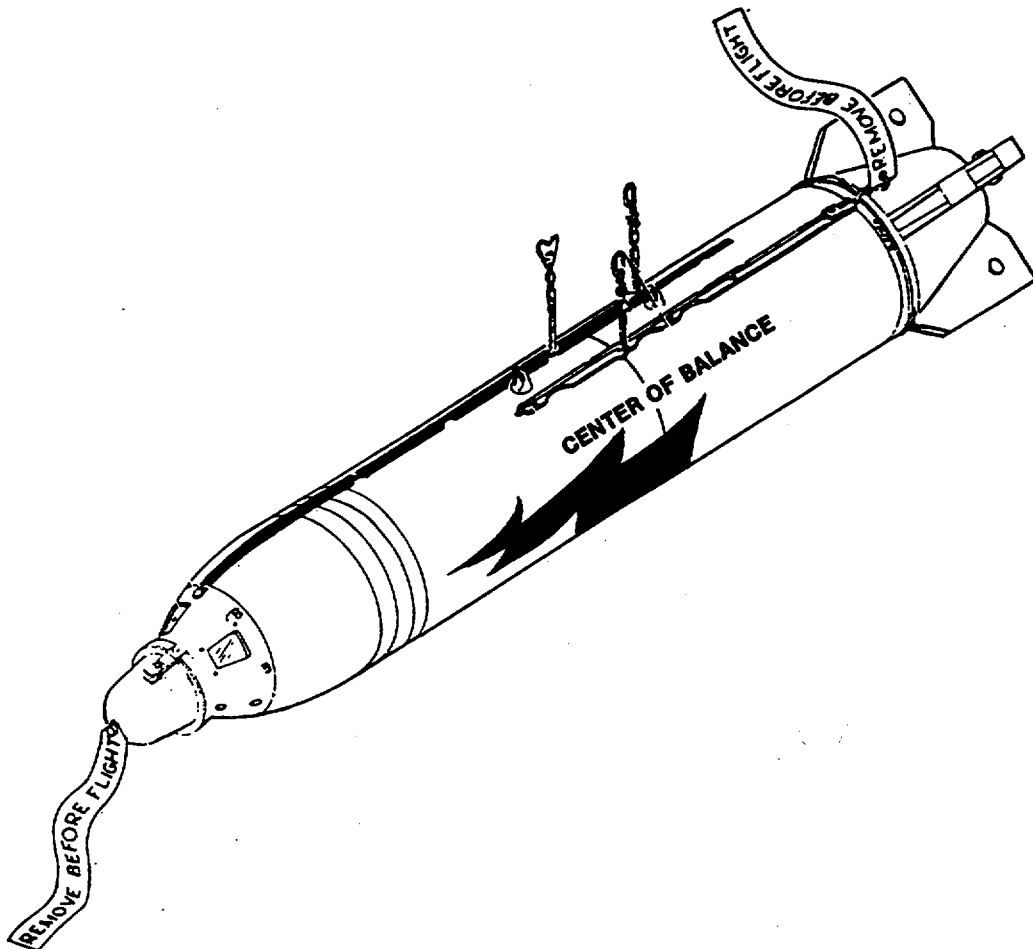


Figure 2-10. CBU-59/B APAM.

and similar targets. It also uses a controlled fragmentation warhead to provide maximum fragmentation against soft targets. In the hard-target mode, bomblets will penetrate and detonate on the inside. In the soft-target mode, the bomblet hits the ground and ejects its aft part into the air where it detonates to produce damage through fragmentation. The pyrophoric cup also enhances the bomblets' capability against highly flammable targets.

**c. CBU-78/B Gator.** The CBU-78/B Gator (see fig. 2-11) provides a means for rapidly planting a minefield. The mines are extremely effective against armored vehicles and personnel for area

denial and harassment. The ability to select the self-destruct time for the mines allows tactical counterattack by friendly forces.

The major parts of the Gator weapon are the dispenser, the dispenser fuze, and 60 mines (45 BLU-91/B antitank and 15 BLU-92/B antipersonnel). The Gator dispenser has the word GATOR in large stenciled letters painted on each side of the case.

The primary differences between mines are the warheads and target sensors. The BLU-91/B antitank unit detonates through a magnetic sensor which detects a vehicle overpass. The BLU-92/B

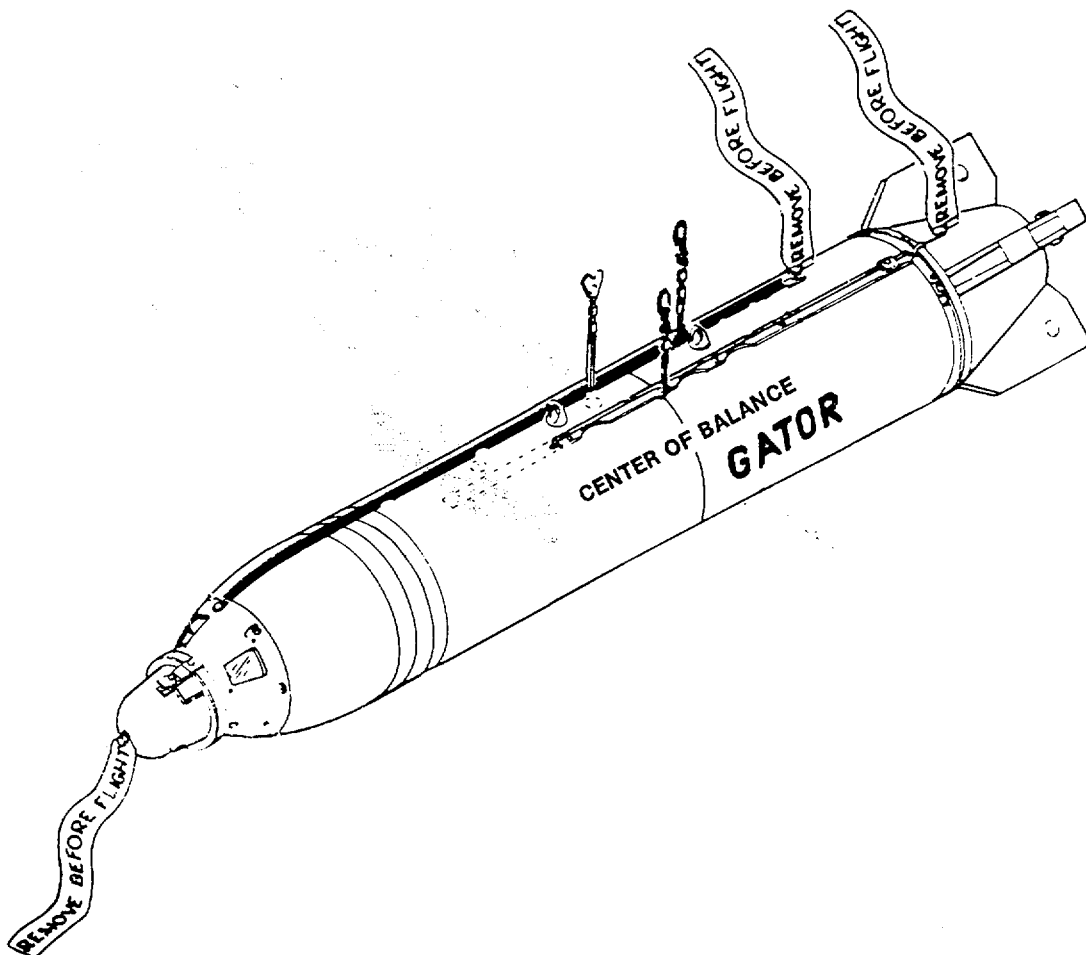


Figure 2-11. CBU-78/B Gator.

antipersonnel mine uses tripwires expelled from the mine for target detection and firing/detonation. Detonation of either mine can be due to target detection, mine disturbance, loss of cell voltage, or preset self-destruct.

## 2006. Guns

Aircraft guns are an important weapons system providing both offensive and defensive firepower. Aircraft guns can deliver air-to-air and air-to-ground fire. They are effective against personnel and unprotected, light, and medium armored surface targets. Flexible mounted machine guns can provide self-protection in the form of suppressive fire.

**a. GAU-12 25mm Gun System.** The GAU-12 25mm gun system of the AV-8B (see fig. 2-12) is a high rate of fire (3,600 rpm) gun for air-to-air and air-to-ground attack. The gun is effective against all types of lightly armored vehicles. The

system has two pod-like structures (called paks) mounted to the bottom of the aircraft fuselage. The left pak contains the gun. The right pak contains 300 rounds of linkless ammunition. A crossover fairing connects the two paks. The gun fires a variety of 25mm ammunition including the Bushmaster family, standard NATO, and the newly developed Navy family.

**b. M-61A1 20mm Automatic Gun.** The M-61A1 20mm automatic gun (see fig. 2-13) is a six-barrel rotary action mechanism operated by a hydraulic drive unit. The gun fires M-50 series ammunition at selectable rates of 4,000 (low) or 6000 (high) rounds per minute (rpm). The F/A-18 uses the M-61A1. The M-50 series ammunition is being replaced by the more capable PGU-28 20mm round.

**c. A/A49E-7(V4) 20mm Turret System.** The turret system on the AH-1W is chin-mounted. The system provides for sighting, feeding, and firing the M-197 three-barrel, rotary action 20mm gun.

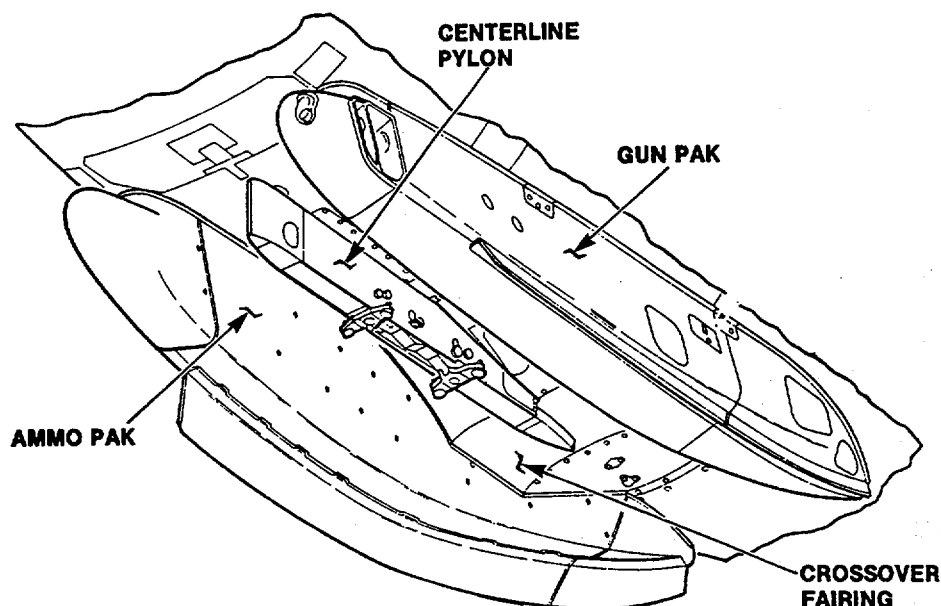


Figure 2-12. GAU-12 25mm Gun System.



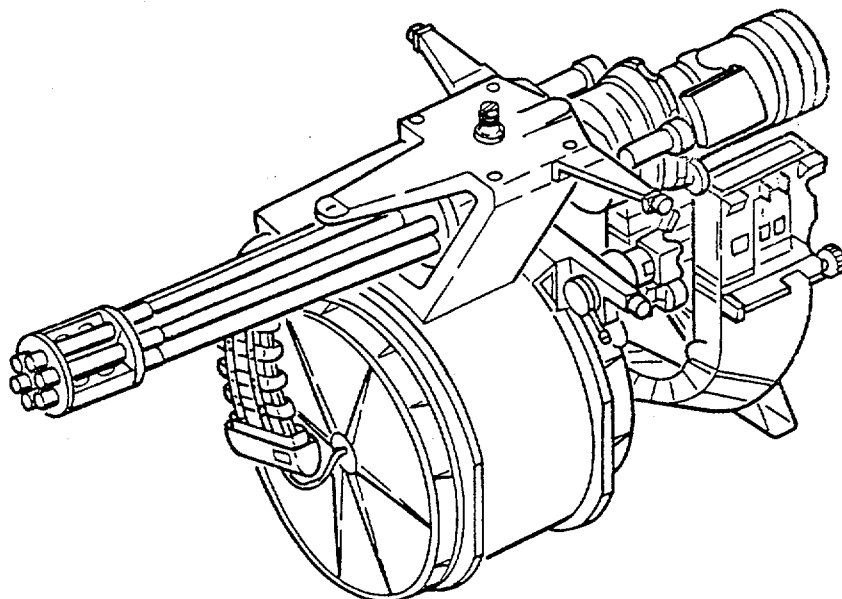


Figure 2-13. M-61A1 20mm Gun.

The turret can traverse 110 degrees to either side and depress to 50 degrees. (See fig. 2-14.) The gun has a firing rate of about 650 rpm and a magazine capacity of 750 rounds. The AH-1W, AH-1T, and AH-1J have different turret systems. The capabilities of the aircraft are—

AH-1J	AH-1T/W
Flexible sight	Telescopic sight unit (TSU)
Fixed forward	Helmet sight subsystem (HSS)
	Fixed forward

**d. GPU-2/A Gun Pod.** The GPU-2/A gun pod (see fig. 2-15) consists of the M-197 20mm gun, a linkless ammunition system, and an ammunition storage drum. The ammunition storage drum has a 300-round capacity. The M-197 provides a 750- or 1500-rpm rate of fire.

**e. XM-218/GAU-16 .50-Cal. Machine Gun.** The XM-218 aircraft machine gun (see fig. 2-16) can be mounted on all assault transport helicopters.

The UH-1N uses the GAU-16. It provides medium-range suppressive fire at a cyclic rate of 750 to 850 rpm. The gun can use open iron sights or a laser sight for NVG operations.

**f. M-60 7.62mm Machine Gun.** The M-60 7.62mm aviation machine gun (see fig. 2-17) is an adaptation of the M-60 ground machine gun. Marine aircraft use two versions of the M-60. The OV-10 has a pair of M-60C machine guns integrally mounted in each sponson. Assault support transport helicopters use the flexible mounted M-60D. Both versions have a cyclic rate of 550 rpm.

**g. GAU-17 7.62mm Weapon System.** The GAU-17, used on the UH-1N, provides high-density, medium-range suppressive fire. The weapon system (see fig. 2-18) consists of three main parts: the control box, the ammunition storage system, and the gun. The system can fire 2,000 or 4,000 rpm. The GAU-17 can use a laser sight during NVG operations. When installed, the system reduces the internal space available for troops or cargo.

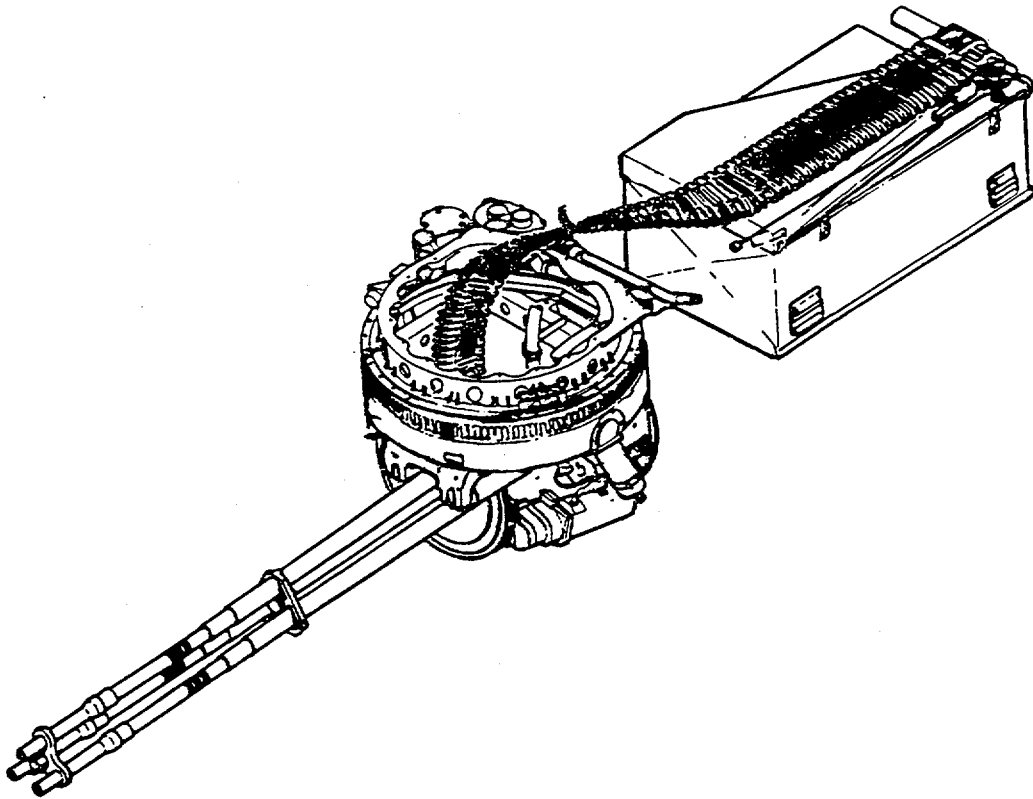


Figure 2-14. AH-1 20mm Turret.

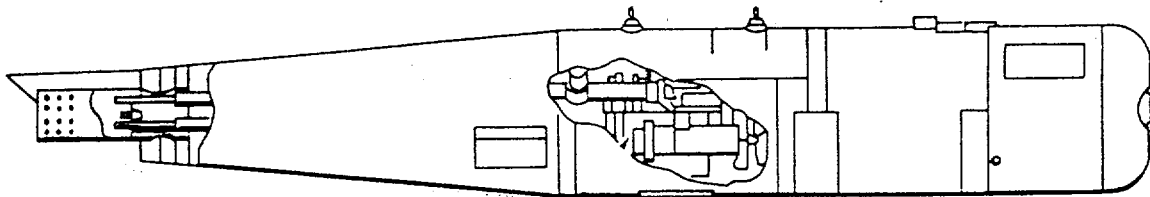


Figure 2-15. GPU-2/A Gun Pod.

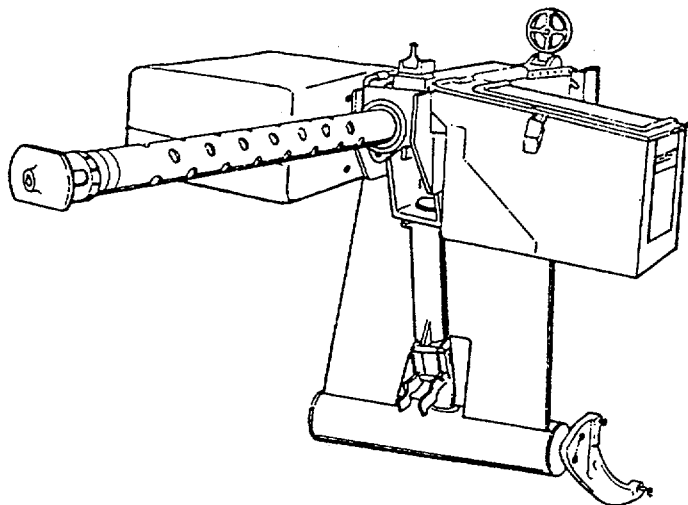


Figure 2-16. XM-218 .50-Cal. Machine Gun.

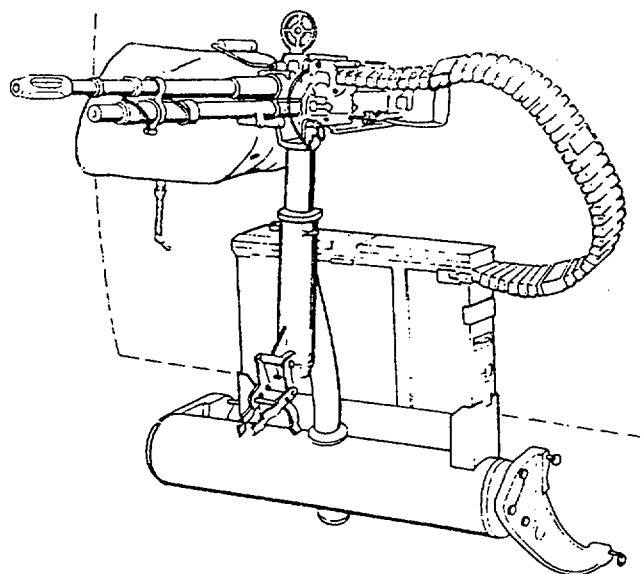


Figure 2-17. M-60 7.62mm Machine Gun.

## 2007. Rockets

The Marine Corps uses two types of rockets, the 2.75-inch rocket and the 5-inch rocket. Equipped with the appropriate warhead, the 2.75-inch and 5.0-inch rocket provide an effective capability against a variety of targets. Aircraft rockets have an unguided boost phase and a ballistic flight phase. The 5-inch rocket is no longer being bought. The 5-inch rocket and the current 2.75-inch rocket are being replaced by the 2.75-inch advanced rocket system (ARS).

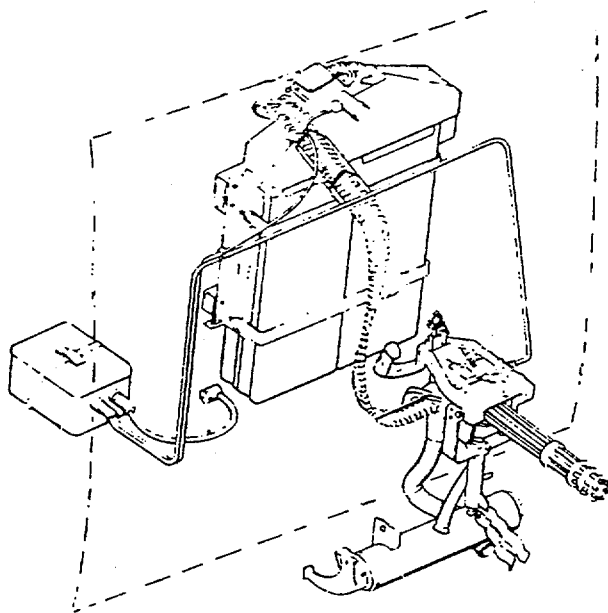
**a. 2.75-inch Rocket.** The 2.75-inch rocket can be fired from two different pods. The LAU-68 carries 7 rockets and the LAU-61 carries 19 (see fig. 2-19). Rockets can be fired in any number from single to ripple (rapid repeat). In combat, ripple firing increases the chances of hitting the target. A 2.75-inch submunition warhead for use against armor is under development.

The following is a summary of 2.75-inch warheads. Individual warheads can use a variety of fuzes, from point detonating to variable timed, depending on the target and desired results.

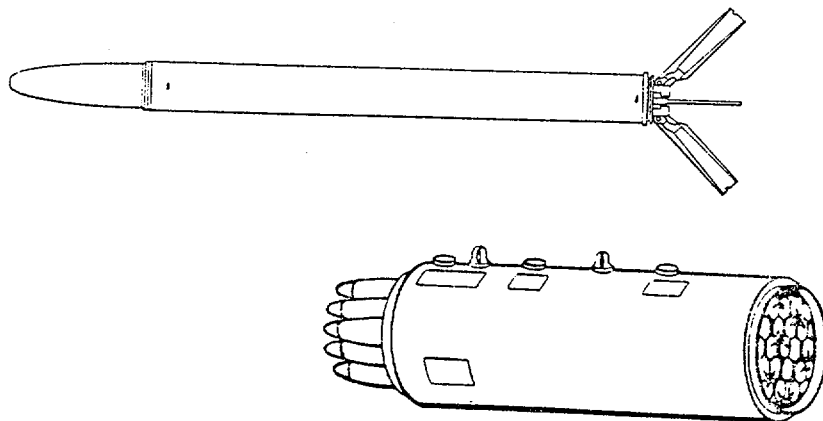
(1) **M-151 (HE Frag).** Use the M-151 warhead against personnel and soft targets (parked aircraft, personnel carriers, radar emplacements, trucks, and small craft).

(2) **M-229 (HE Frag).** The M-229 warhead is an elongated version of the M-151 warhead. Use the M-229 on the same targets as the M-151. Only slow speed aircraft can use the M-229.

(3) **MK-5 (HEAT).** Use the MK-5 warhead against hardened targets (tanks, bunkers, and armored vehicles). The shaped-charge warhead uses a high energy jet to penetrate armor.



**Figure 2-18. GAU-17 Weapon System.**



**Figure 2-19. 2.75-Inch Rocket and LAU-61 Pod.**

(4) **MK-67 (Smoke).** Use the MK-67 for target marking. The casing consists of a thin-walled aluminum casting.

(5) **M-156 (Smoke).** The M-156 warhead is the same in function to the MK-67 but uses a soft steel casing.

(6) **M-257 (Flare).** Use the M-257 flare warhead to provide standoff battlefield illumination. The warhead produces 1 million candlepower for a minimum of 100 seconds and illuminates about 1 square mile.

(7) **WDU-4A/A (Flechette).** Use this warhead against personnel and lightly armored targets. It contains 2,200 small arrow-shaped projectiles (flechettes).

**b. 5-Inch Rocket.** The 5-inch rocket is fired from a four-tube LAU-10 rocket pod (see fig. 2-20). Rockets can be fired in any number from single to ripple (rapid repeat). The best ground fragmentation pattern is achieved by firing one or more pods on the same pass.

The following is a summary of 5.0-inch warheads. Individual warheads can use a variety of fuzes, from point detonating to variable timed, depending on the target and desired results.

(1) **MK-24 (HE GP).** Use the MK-24 warhead against a variety of targets including concrete buildings, bunkers, or surface vessels.

(2) **MK-63 (HE Frag).** The MK-63 warhead produces large quantities of fragments in an effective air burst pattern.

(3) **MK-32 (HEAT/APERS).** The MK-32 is a shaped-charge warhead effective against heavy or light armored targets.

(4) **MK-34 (Smoke).** Use the MK-34 warhead for target marking or to start fires. It provides a smoke screen for about 4 to 5 minutes.

(5) **MK-33 (Flare).** The MK-33 contains a pyrotechnic candle and a parachute. The flare burns for about 90 seconds and provides illumination of 1 million candlepower.

(6) **MK-84 (Chaff).** The MK-84 provides a standoff method of employing chaff into a desired area or along a selected flight route. The warhead contains a multiband chaff payload.

(7) **MK-29 (AP).** The MK-29 is an armor-piercing warhead designed for antisubmarine warfare use. Target damage depends on the

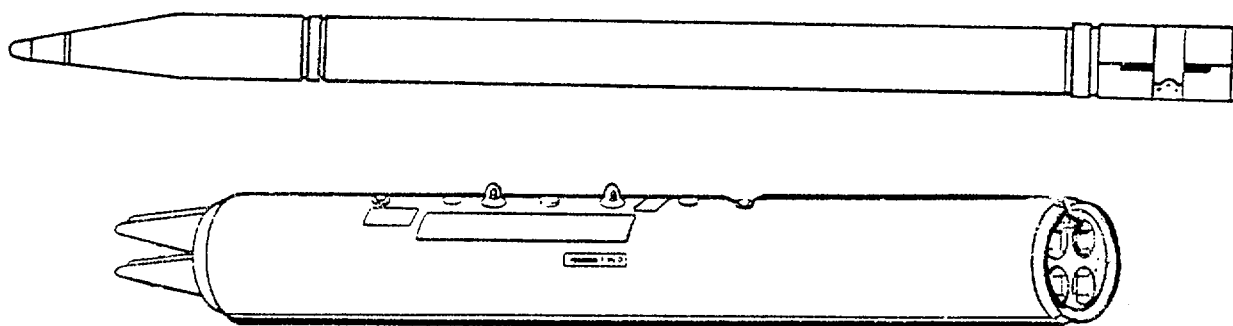


Figure 2-20. 5-Inch Rocket and LAU-10 Pod.

kinetic energy of the warhead on impact. The nose shape enhances water entry and underwater travel, permitting attack against submerged but near surface targets.

## 2008. Air-To-Surface Guided Missiles

Air-to-surface guided missiles have improved ground attack capabilities in high threat environments. These weapons provide increased accuracy, improved warhead effectiveness, and standoff capabilities against hard or specialized targets.

### a. Antiradiation Missiles

(1) **AGM-45 Shrike.** The Shrike is a 400-pound, antiradar missile (see fig. 2-21) capable of detecting and homing on pulse-type radars. Shrike's range is highly dependent upon the mode of delivery.

(2) **AGM-88A.** The AGM-88A high-speed anti-radiation missile (HARM) (see fig. 2-22) is a high speed weapon designed to attack enemy air defenses. HARM will replace the Shrike missile and is effective against the full spectrum of threat radars. Baseline aircraft for the HARM are the F/A-18 and EA-6B.

(3) **AGM-122A Sidearm I.** The Sidearm (see fig. 2-23) is a short-range, quick reaction, antiradiation missile. It uses the AIM-9 Sidewinder motor with a radio frequency (RF) seeker head in place of the IR seeker head. Currently only the AH-1W and AH-1T can carry the Sidearm. There are plans for the OV-10 and AV-8B to carry the Sidearm.

b. **AGM-65 Maverick Missile.** Use the AGM-65 Maverick missile (see fig. 2-24) against field fortifications, surface-to-air missile (SAM) sites, and armored vehicles. There is a laser guided variant (AGM-65E) and an imaging IR seeker variant (AGM-65F). The forward section of the missile contains the guidance unit. The missile contains a warhead, a safety arming and fuze unit, battery, and rocket motor. The F/A-18 and AV-8B can use the IR Maverick. The AV-8B is the only aircraft cleared to fire the laser Maverick.

c. **Airborne TOW (M-65).** The M-65 airborne TOW provides the capability to conduct point target attack of armor. The AH-1W and AH-1T are the only aircraft that use the M-65 TOW. The aircraft can carry two twin launchers for a total of eight missiles. The system consists of the gyro-stabilized nose sight, missile control and stabilization, and operating controls and indicators for

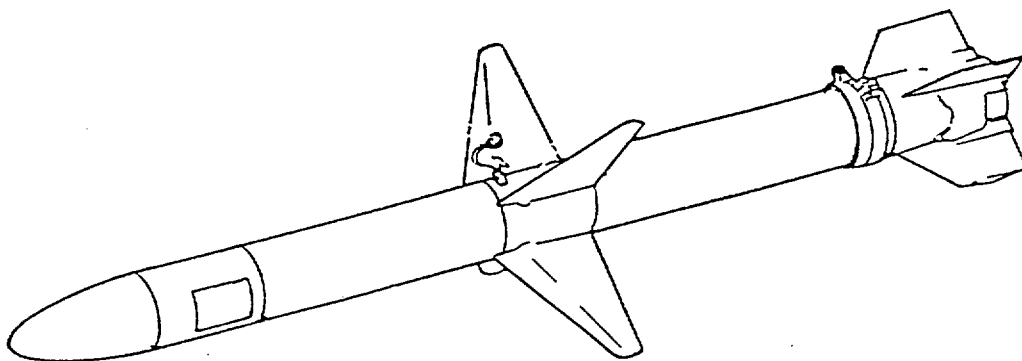


Figure 2-21. AGM-45 Shrike Missile.

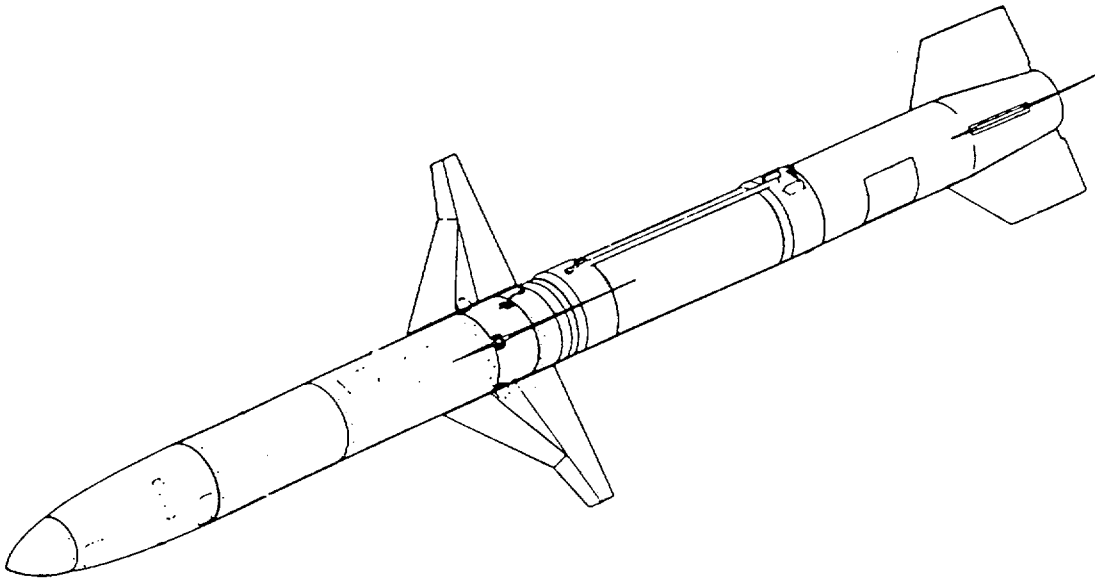


Figure 2-22. AGM-88 HARM.

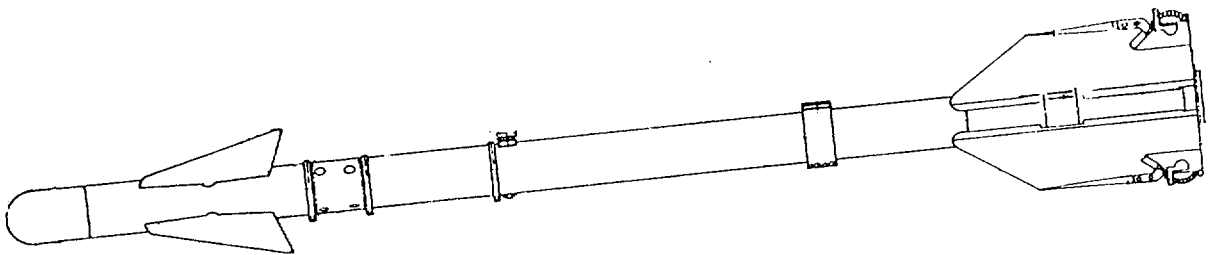


Figure 2-23. AGM-122A Sidearm I.

the gunner and pilot. The missile receives commands from two wires attached to the launcher tubes.

The AH-1W and AH-1T can carry basic TOW, extended range TOW, improved TOW (ITOW), and TOW-2 missiles. The TOW missile (see fig. 2-25) is a command guidance round. It has a minimum effective range of 500 meters and a maximum effective range of 3,750 meters. The missile has a shaped-charge warhead. The ITOW has a probe to defeat reactive armor. The TOW-2

includes improvements to deal with enemy countermeasures.

**d. AGM-114B Hellfire Missile.** The Hellfire missile (see fig. 2-26) is a laser-guided, antiarmor missile. It provides pinpoint accuracy from a safe standoff distance. The missile can lock on to targets before or after launch. Modes of fire include direct (target in sight) and indirect (target not in sight). Only the AH-1W can carry the Hellfire. Plans call for the AV-8B to have this capability after FY 95.

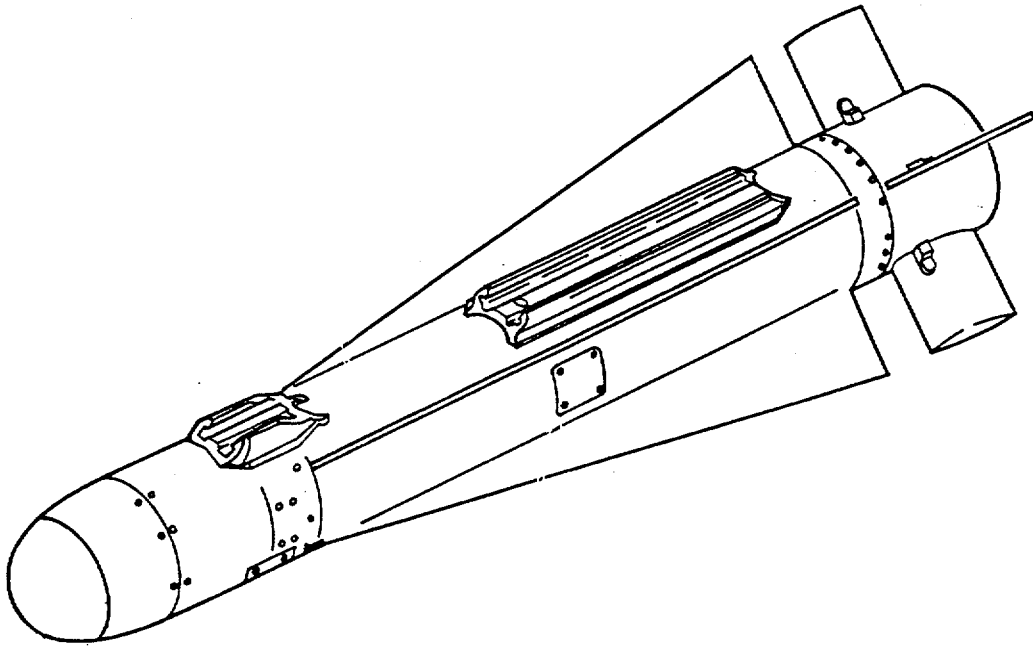


Figure 2-24. AGM-65 Maverick Missile.

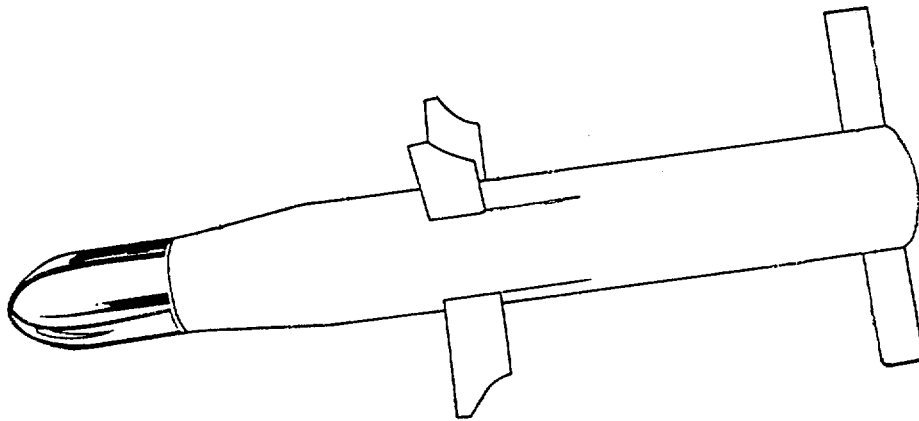


Figure 2-25. TOW.

## 2009. Air-To-Air Missiles

Air-to-air missiles have significantly increased the range for engaging enemy aircraft. This extension in firing ranges provides aircraft more opportunity for engagement and offers less exposure time to hostile aircraft. The AIM-7 Sparrow III is the intermediate-range missile which does not require visual acquisition of the target aircraft. The AIM-9

Sidewinder missile enhances the close-in capability in an air combat maneuvering environment.

**a. AIM-7 Sparrow III.** The Sparrow III (see fig. 2-27) is a radar homing, all weather, all altitude, air-to-air missile. The Sparrow requires the aircraft weapon system to lock on an enemy target before missile launch. After launch, the Sparrow



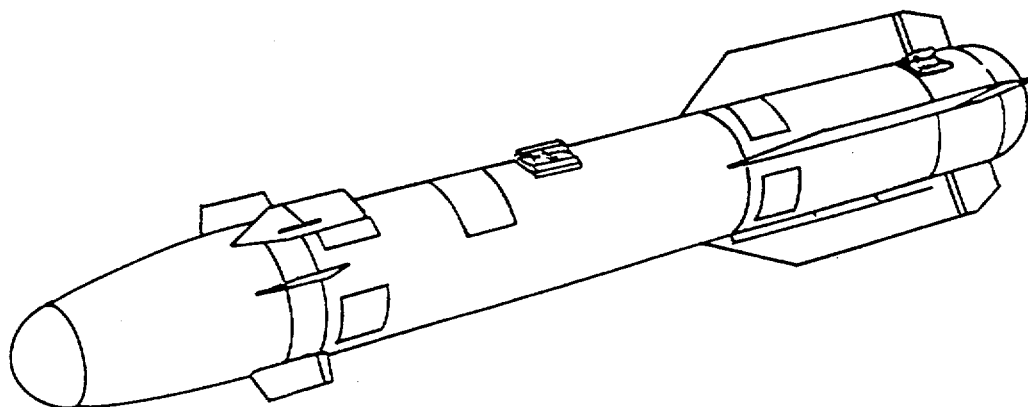


Figure 2-26. AGM-114B Hellfire Missile.

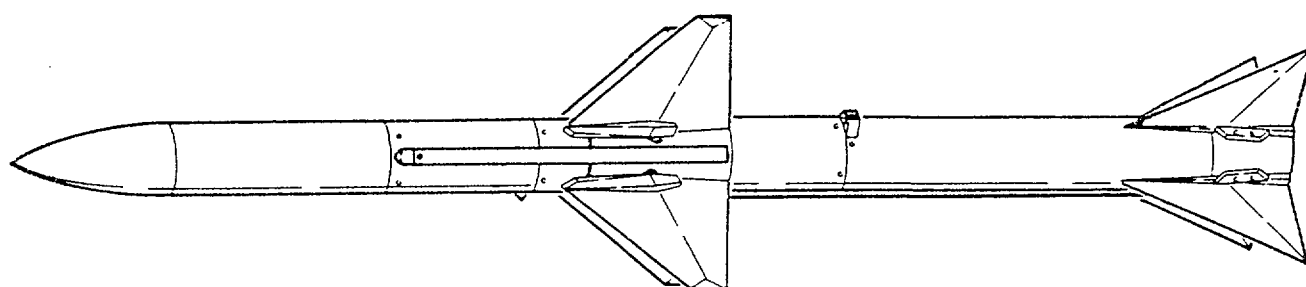


Figure 2-27. AIM-7 Sparrow Missile.

follows the radar illumination to the target and completes the intercept. Improvements to the Sparrow include advancements in close-in air combat maneuvering capability.

**b. AIM-9 Sidewinder.** The Sidewinder (see fig. 2-28) is an IR homing missile. It is the only heat-seeking air-to-air missile available to Marine aviation. All fighter and attack aircraft can fire the Sidewinder. The Sidewinder is one of the simplest and cheapest guided missiles produced. The latest version of the Sidewinder has an *all aspect* capability. This allows use from virtually any angle in an air combat maneuvering environment.

## 2010. Aircraft Flares

All Marine attack aircraft, the OV-10, and the KC-130 can use aircraft flares with a dispenser. Assault support helicopters and the KC-130 can drop aircraft flares by hand.

### a. Flares

**(1) MK-45 Parachute Flare.** The MK-45 parachute flare (see fig. 2-29) provides 210 seconds of 2 million candlepower illumination. The flare contains a pyrotechnic candle, a parachute, an ejection mechanism, a fuze, and

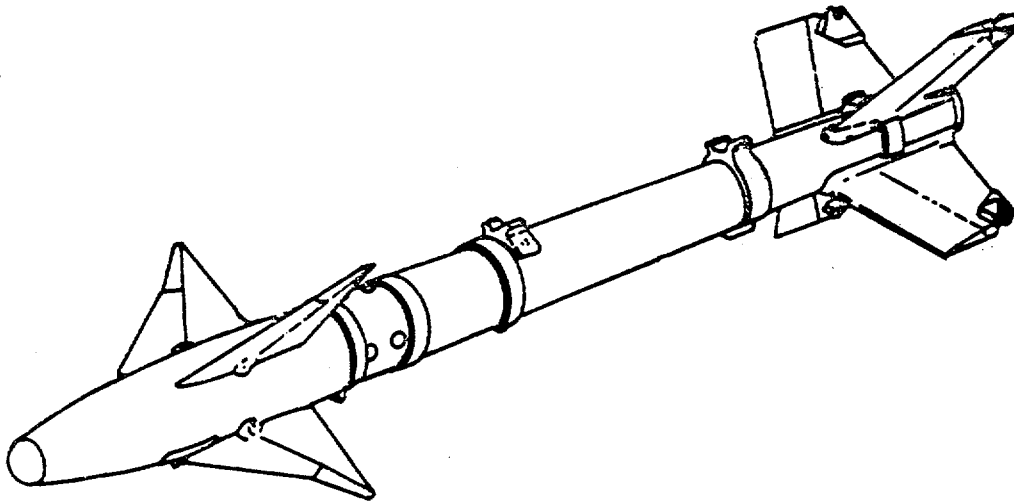


Figure 2-28. AIM-9 Sidewinder Missile.

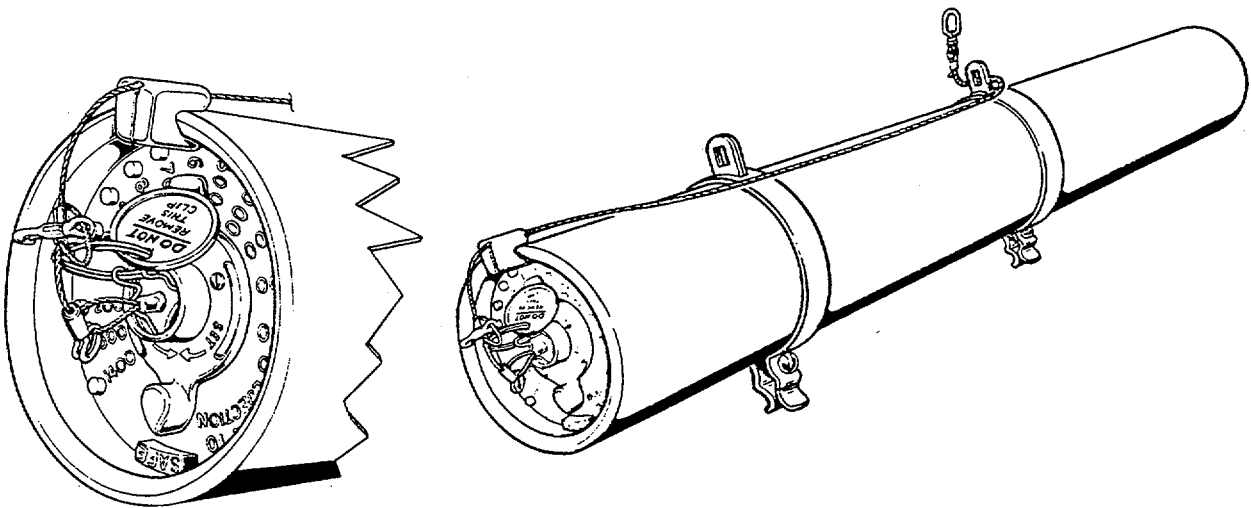


Figure 2-29. MK-45 Parachute Flare.

a case. At the end of the flare burn, an explosive bolt cuts most of the parachute shroud lines. This results in the parachute's collapse, causing it and the spent candle to fall to the ground.

(2) **LUU-2 Parachute Flare.** The LUU-2 parachute flare (see fig. 2-30) provides up to 4 minutes of 2 million candlepower illumination. The flare consists of a cylindrical aluminum container enclosing a timer, parachute, and candle.

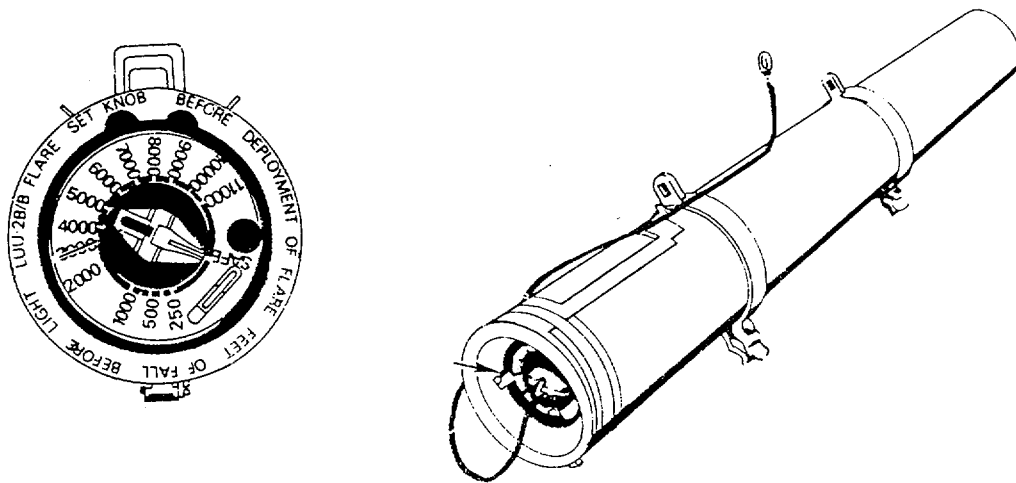


Figure 2-30. LUU-2 Parachute Flare.

#### b. Dispensers

(1) **SUU-44.** The SUU-44 dispenser is a four-tube launcher capable of carrying and ejecting rearward eight parachute flares. Each tube holds two flares. The SUU-44 ejects both flares in a tube with each firing impulse.

(2) **SUU-25.** The SUU-25 dispenser is a four-tube launcher capable of carrying and ejecting rearward eight parachute flares. Each tube holds two flares. Unlike the SUU-44 the SUU-25 can eject one flare at a time. This ability doubles its operational capability in comparison to the SUU-44.

## Chapter 3

# Surface-To-Air Weapons

Effective AAW operations are essential to every MAGTF operation. The MAGTF uses two surface-to-air weapon systems as components of its integrated air defense. The low altitude air defense (LAAD) battalion uses the Stinger, while the light antiaircraft missile (LAAM) battalion uses the Hawk.

### 3001. Stinger

The Stinger (see fig. 3-1) is a shoulder-fired, rocket propelled, IR seeking missile. The Stinger provides a responsive antiaircraft weapon for the close-in, low-altitude air defense requirements of the MAGTF. The Stinger can acquire, track, intercept, and destroy low-flying fixed-wing and rotary wing aircraft. An improved Stinger with a reprogrammable microprocessor is now being fielded. The improved Stinger can detect and track the ultraviolet, in addition to IR, signature of target aircraft. The Stinger includes an integral identification friend or foe (IFF) subsystem that helps the gunner identify aircraft.

Missile length	4 feet 10 inches
Missile diameter	2.75 inches
Missile weight	34.5 pounds w/launcher

### 3002. Hawk

The Hawk (see fig. 3-2) detects targets with two types of acquisition radars. The continuous wave acquisition radar provides low-to-medium altitude detection coverage. The pulse acquisition radar provides medium-to-high altitude detection coverage. Following

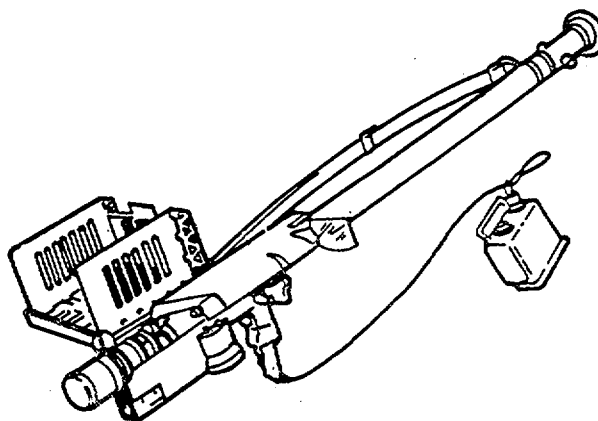
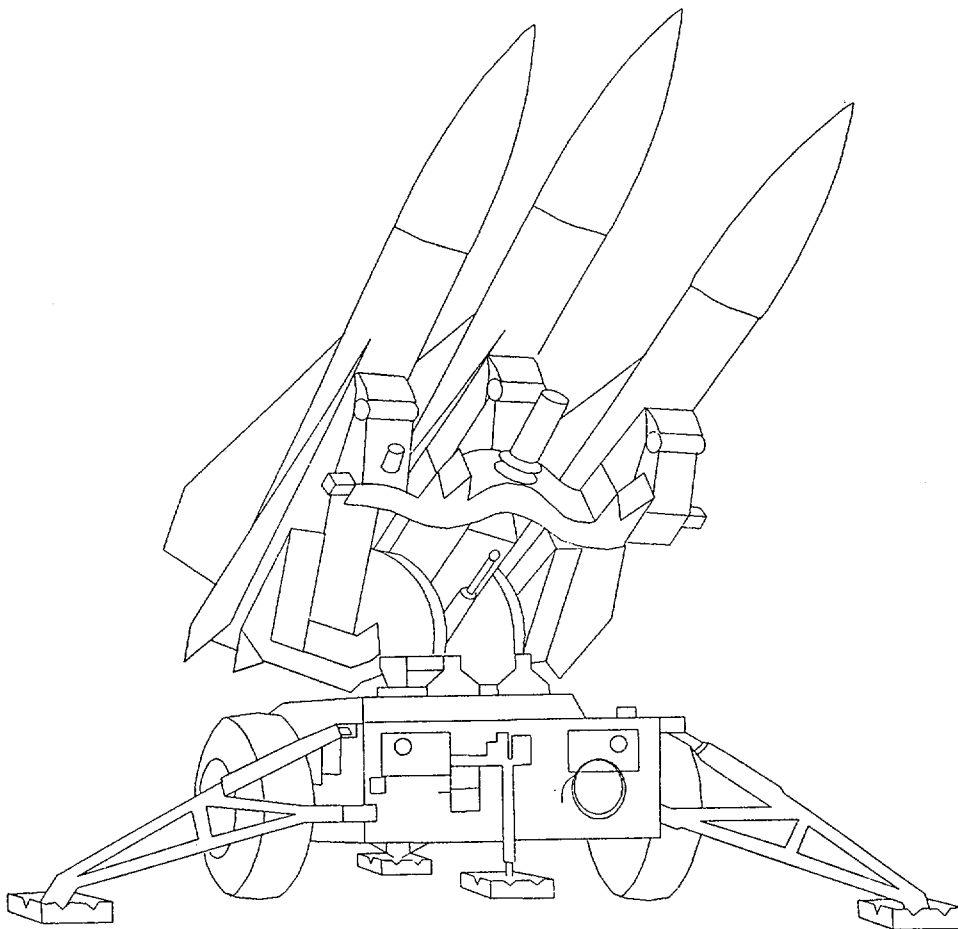


Figure 3-1. Stinger.

detection, targets to be engaged are assigned to a high power illuminator radar (HPIR). The HPIR tracks the target and provides a reference signal to the missile. The missile homes on the target by continuous comparison of the transmitted signal from the HPIR with the reflected signal from the target. The Hawk uses the reflected signal to adjust its course and intercept the target.

Missile length	16 feet 6 inches
Missile wingspan	3 feet 11 inches
Missile weight	1,375 pounds



**Figure 3-2. Hawk and Launcher.**

## Appendix A

# Major Components of Marine Corps Aviation

### First Marine Aircraft Wing

#### MWHS-1 (FOSTER)

3d SSCT  
7th CIT  
FIU

#### MACG-18 (FUTEMA)

HQ, MACG-18  
MTACS-18  
MATCS-18  
MATCS-18 DET (TWENTYNINE PALMS)  
MASS-2  
MACS-4  
1st LAAD Bn  
MWCS-18(—) (FOSTER)

#### MAG-12 (IWAKUNI)

HQ, MAG-12  
MALS-12  
VMA(AW)<sup>1 2</sup>  
VMA<sup>1</sup>  
VMFA<sup>1</sup>  
DET, VMAQ-2<sup>1</sup>  
DET, MATCS-18

#### MAG-36 (FUTEMA)

HQ, MAG-36  
MALS-36  
HMM<sup>1</sup>  
HMH<sup>1</sup>  
HML/A(—)<sup>1</sup>  
VMGR-152

#### MWSG-17 (FOSTER)

H&HS-17  
MWSS-171 (IWAKUNI)  
MWSS-172 (FETUMA)  
MWSS-173 (TWENTYNINE PALMS)  
MWSS-174 (Kaneohe Bay)

<sup>1</sup> Units deployed TAD from 2d MAW, 3d MAW, or brigade assets.

<sup>2</sup> VMA(AW) squadrons are being replaced by VMFA(AW) squadrons.

### First Marine Brigade

#### MAG-24 (Kaneohe)

HQ, MAG-24  
MALS-24  
DET B, MATCS-18  
VMFA-212  
VMFA-232  
VMFA-235  
HMM-165  
HMM-262  
HMM-265  
HMM-364  
HMH-463  
MACS-2  
MWSS-174  
MWCS-18 UNIT B  
MATCS-18 DET B

## Second Marine Aircraft Wing

### MWHS-2 (CHERRY POINT)

6th SSCT  
8th CIT  
FIU  
MWWU-Lant

### MAG-31 (BEAUFORT)\*

HQ, MAG-31  
MALS-31  
VMFA-115  
VMFA-122  
VMFA-251  
VMFA-312  
VMFA-333  
VMFA-451

### MACG-28 (CHERRY POINT)

HQ, MACG-28  
MTACS-28  
MWCS-28  
MASS-1  
MACS-6  
2d LAAD Bn  
3d LAAM Bn  
MATCS-28 (NEW RIVER)  
DET A (BEAUFORT)  
DET B (BOGUE FIELD)  
MACS-5 (BEAUFORT)

### MAG-14 (CHERRY POINT)\*

HQ, MAG-14  
MALS-14  
VMA(AW)-224  
VMA(AW)-332  
VMFA(AW)-533  
VMGR-252  
VMGRT-253  
VMAQ-1  
VMAQ-2

### MAG-29 (NEW RIVER)\*

HQ, MAG-29  
MALS-29  
HMM-162  
HMM-263  
HMM-365  
HMH-464  
HMLA-269  
VMO-1

### MWSG-27 (CHERRY POINT)

H&HS-27  
MWSS-271 (BOGUE FIELD)  
MWSS-272 (NEW RIVER)  
MWSS-273 (BEAUFORT)  
MWSS-274 (CHERRY POINT)

### MAG-32 (CHERRY POINT)\*

HQ, MAG-32  
MALS-32  
VMA-223  
VMA-231  
VMA-331  
VMA-542  
VMAT-203

### MAG-26 (NEW RIVER)

HQ, MAG-26  
MALS-26  
HMM-261  
HMM-264  
HMM-266  
HMH-362  
HMH-461  
HMLA-167  
HMT-204

\* Deploys units TAD to 1st MAW on a rotating 6-month basis.

**Third Marine Aircraft Wing****MWHS-3 (EL TORO)**

4th SSCT  
6th CIT  
FIU  
MWWU-Pac (YUMA)

**MAG-39 (CAMP PENDLETON)\***

HQ, MAG-39  
MALS-39  
HML/A-169  
HML/A-267  
HML/A-367  
HML/A-369  
VMO-2  
HMT-303

**MACG-38 (EL TORO)**

HQ, MACG-38  
MTACS-38  
MWCS-38  
MASS-3 (PENDLETON)  
MACS-1 (PENDLETON)  
MACS-7 (YUMA)  
2d LAAM Bn (YUMA)  
3d LAAD Bn (PENDLETON)  
MATCS-38 (PENDLETON)  
MATCS-38 Det (TUSTIN)

**MAG-11 (EL TORO)**

HQ, MAG-11  
MALS-11  
VMGR-352  
VMFA-314  
VMFA-323  
VMFA-531  
VMFA(AW)-121  
VMFA(AW)-242  
VMFAT-101  
VMAQ-3  
VMAQ-4

**MAG-16 (TUSTIN) \***

HQ, MAG-16  
MALS-16  
HMM-161  
HMM-163  
HMM-164  
HMM-166  
HMM-268  
HMH-361  
HMH-363  
HMH-462  
HMH-465  
HMH-466  
HMT-301  
HMT-302

**MWSG-37 (EL TORO)**

H&HS-37  
MWSS-371 (YUMA)  
MWSS-372 (PENDLETON)  
MWSS-373 (EL TORO)  
MWSS-374 (TUSTIN)

**MAG-13 (YUMA)**

HQ, MAG-13  
MAL-13  
VMA-211  
VMA-214  
VMA-311  
VMA-513

\* Deploys units TAD to 1st MAW on a rotating 6-month basis.



## Appendix B

### Squadron Abbreviated Designations

There are 10 types of Marine aircraft squadrons.

- Fighter/attack
- Fighter/attack (all weather)
- Attack
- Attack (all weather)
- Tactical electronic warfare
- Air refueler/transport
- Observation
- Light/attack helicopter
- Medium helicopter
- Heavy helicopter

Marine aircraft squadron designations are explained below. NWP 3, *Naval Terminology* is the authorized source for all designations. Squadron designations are formed by combining certain letters. Figure B-1 contains examples of squadron designations.

1. The first letter designates aircraft class —
  - V — Airplane/fixed-wing
  - H — Rotorcraft/helicopter
2. The second letter designates operating Service —
  - M — Marines
3. Subsequent letters designate the general aircraft category, type of mission, and specific capabilities.
  - A — Attack
  - F — Fighter

- G — Air refueler
- O — Observation
- P — Tactical reconnaissance
- R — Transport
- T — Training
- H — Heavy (helicopter lift capability)
- M — Medium (helicopter lift capability)
- L — Light (helicopter lift capability)
- X — Experimental/special mission
- (AW) — All weather

VMFA-312	F/A-18
VMGR-252	KC-130
VMO-1	OV-10
HMM-162	CH-46
VMA(AW)-224	A-6
HML/A-169	AH-1W/UH-1N
VMFA(AW)-121	F/A-18D
VMAQ-2	EA-6B

**Figure B-1. Abbreviated Designations, Marine Aircraft Squadrons.**

## Appendix C

### Delivery Maneuvers and Accuracy

To be effective, a weapon must be accurately placed on the correct target at the correct time. Selection of a delivery maneuver depends on the tactical situation. The purpose of the delivery maneuver is to place the aircraft at the correct point in space where weapon release will produce the desired results. There are four categories of delivery maneuvers:

- Level delivery
- Dive delivery
- Loft delivery
- Terrain flight (TERF) delivery

Each delivery maneuver is designed for specific situations and desired weapon effect. The choice of delivery maneuver depends on the target, enemy defenses, and weather conditions at the target. For example, a shallow dive to produce waterline hits is more effective against small boats. Use a steep dive, coupled with high airspeed, to attack larger ships.

#### 1. Delivery Maneuvers

##### a. Level Delivery Maneuvers. (See fig. C-1.)

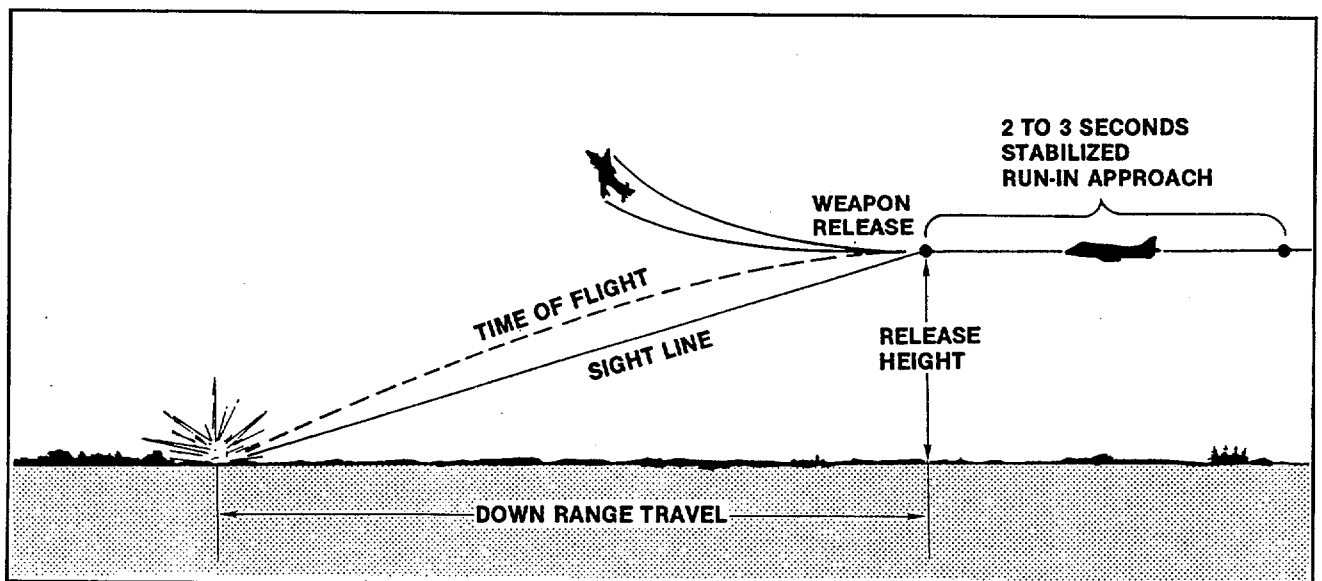


Figure C-1. Level Delivery Maneuvers.

(1) **Low Altitude.** Use low altitude level delivery, below 1,000 feet above ground level (AGL), in a radar or surface-to-air missile environment, or where low clouds prevent other delivery maneuvers. This method also optimizes the effectiveness of certain weapons (e.g., smoke, retarded conventional bombs, and firebombs).

(2) **High Altitude.** Use high altitude level delivery, 1,000 feet AGL and above, at night or when weather prevents visual delivery. These deliveries require radar and weapon computer aid such as ASRT, RABFAC, or onboard aircraft systems (e.g., A-6E TRAM).

**b. Dive Delivery Maneuvers.** There are five standard dive delivery maneuvers. Each has a different purpose and reflects various capabilities. (See fig. C-2.)

(1) **10 Degree.** Use a 10-degree dive maneuver for strafing and delivery of retarded conventional bombs and firebombs. It provides good accuracy and allows delivery under clouds.

(2) **20 Degree.** Use a 20-degree dive maneuver for rockets, strafing, and retarded conventional bombs.

(3) **30 Degree.** 30-degree dive maneuvers are the most accurate for unretarded conventional bombs and rockets.

(4) **45 Degree.** Use a 45-degree dive maneuver for unretarded conventional bombs to increase bomb penetration depth or to avoid heavy ground fire.

(5) **Over 45 Degree.** Steep dive deliveries are those with delivery angles more than 45 degrees. Use steep dives to get a steep weapon impact angle for maximum penetration depth or to reduce exposure to hostile fire. These deliveries require weather conditions which allow pilot acquisition of the target. Accuracy is reduced

due to the relatively long slant range from weapon release point to the target.

**c. Loft Delivery Maneuvers.** Use loft delivery maneuvers to improve aircrew survivability by providing maximum distance from aircraft to target. This maneuver (see fig. C-3) consists of a level run-in to the pullup point. At the pullup point the pilot begins a climb. As the aircraft reaches the loft point, the pilot releases the weapon.

**d. Terrain Flight Maneuvers.** Attack helicopters use TERF maneuvers while flying close to the Earth's surface. These maneuvers allow the aircrew to remain outside or below enemy weapon system envelopes. The principal delivery techniques used are running fire, hovering fire, and pop-up fire.

(1) **Running Fire.** Fire delivered when the aircraft is in forward flight. Running fire can be used to deliver direct and indirect fires. Forward airspeed adds stability to the aircraft and increases weapons delivery accuracy. This type of fire is less vulnerable to enemy air defenses than diving fire.

(2) **Hovering Fire.** Use hovering fire when the aircraft is stationary or has very little forward motion. Use hovering fire after unmasking from a defilade position. Deliver indirect hover fire from firing points (FPs) hidden from the enemy by terrain. Maintain the hover fire position only as long as necessary to deliver ordnance then remask. Where terrain permits, the aircraft should move to an alternate FP. Unguided ordnance is less accurate because the aircraft is not as stable in a hover. Precision guided weapons are the most effective weapon when fired from a hover.

(3) **Pop-Up Fire.** This is a combination of running and diving fire in which the aircraft does a slight climb to perform a shallow dive angle attack. The main advantage of pop-up fire is the increase in accuracy attainable with diving fire.

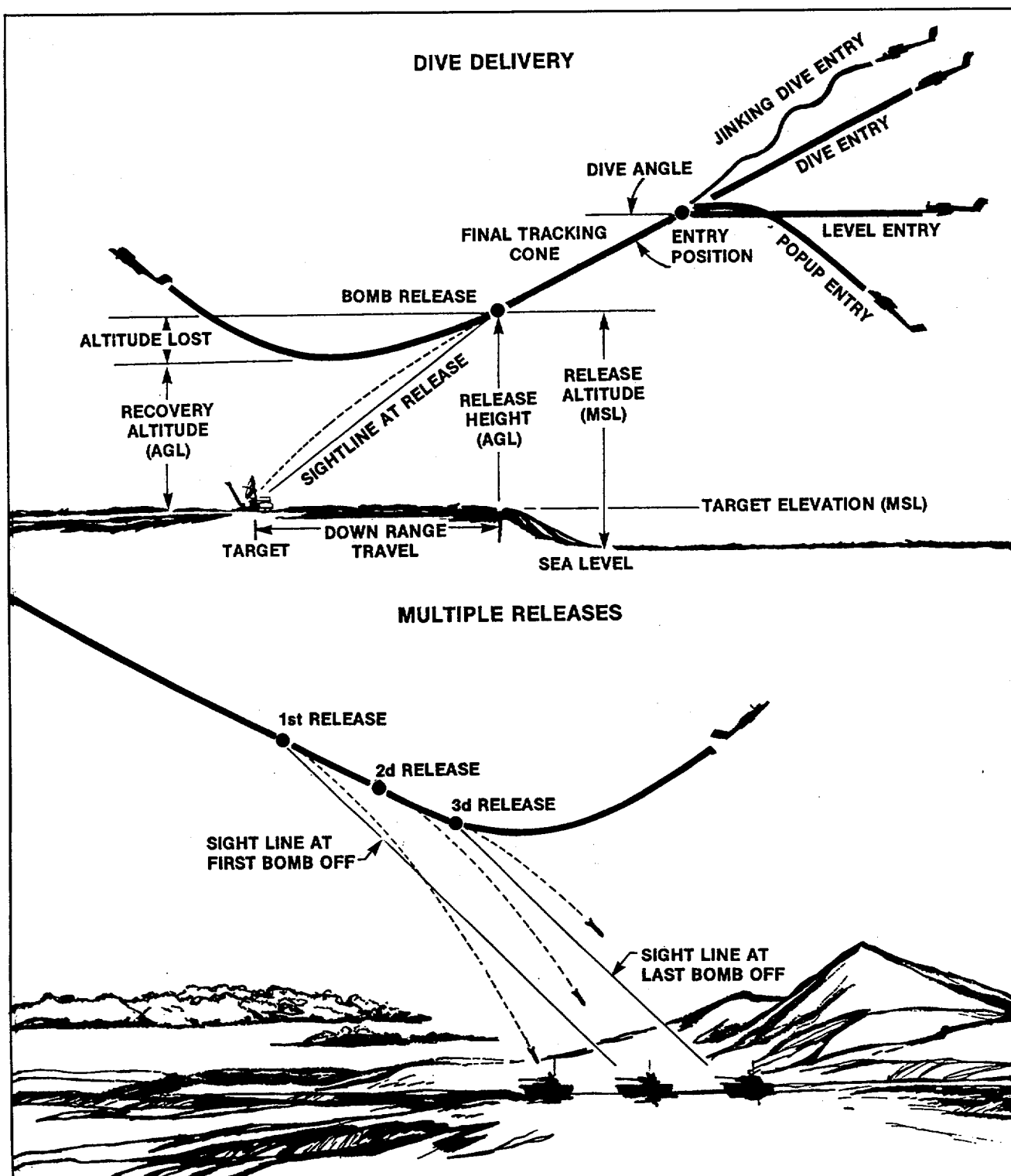


Figure C-2. Dive Delivery Maneuvers.

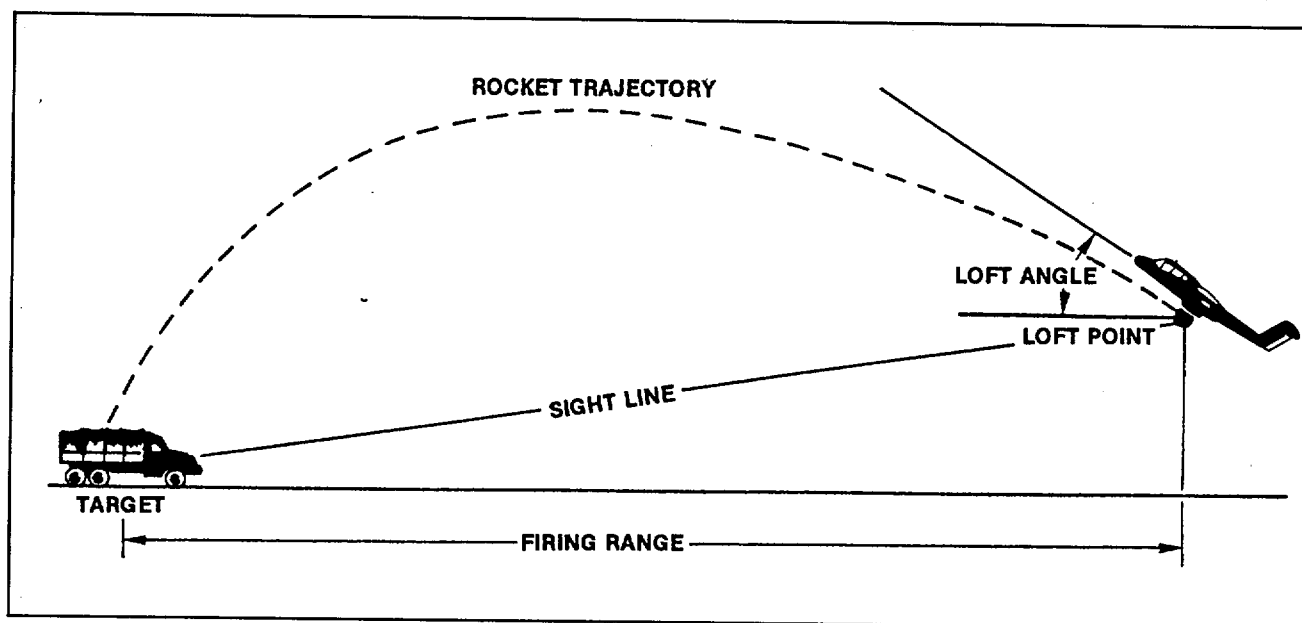


Figure C-3. Loft Delivery Maneuver.

## 2. Strafing

Aircraft guns are versatile, accurate, and can provide sustained concentrations of fire. These characteristics make them highly effective against a wide variety of targets. The three types of strafing are: suppression, line targets, and point targets. Use suppression strafing during bomb runs or rocket runs to keep enemy heads down. When strafing a line target (vehicle convoys, troop columns, line of ships) start firing at long slant ranges using a series of bursts. When strafing a point target, the pilot tries to meet specific firing parameters with a predetermined sight picture. The pilot can assess target damage immediately after cease fire, a feature which enhances delivery effectiveness.

## 3. Delivery Accuracy

Circular error probable (CEP) defines the accuracy of the weapons and weapons systems. CEP is the distance from the target that encloses 50 percent of a given number of weapon impacts. The CEP of 12 bombs, dropped one per pass, would be the distance from the target that six bomb impact (e.g., 30 feet). Delivery accuracy also depends on slant range, ability to find the target, weather, weapon ballistic dispersion, and individual pilot skills.

## Appendix D

# Helicopter Characteristics

Use the following charts for quick reference. For more specific requirements, the individual helicopter NATOPS manuals should be consulted.

### Helicopter HOGE Payload Capability<sup>1</sup>

#### HOGE Payload<sup>2</sup>

Altitude/Temp	UH-1N	CH-46E	CH-53D	CH-53E
Sea level/90°F	1,837	4,251	12,252	28,553
2000'/70°F	1,837	4,250	11,852	27,903
3000'/91.5°F	1,837	4,131	7,251	20,553
4000'/95°F	1,437	2,851	5,652	17,753

1 — Hover out of ground effect (HOGE) is a hover altitude in which the helicopter is in a stable hover at a distance equal to or greater than its rotor diameter above a horizontal surface.

2 — Payload with full internal fuel.

**Deck Space Equivalents of Marine Helicopters, OV-10, and AV-8  
(CH-46 Standard for Measurement)**

<b>Helicopter</b>	<b>CH-46 Equivalents</b>
CH-46	1.0
CH-53E	2.4
CH-53D	1.7/2.2 *
UH-1N	0.8
AH-1J	0.75
AH-1T/W	0.8
AV-8B	1.4
OV-10	1.5

\* With external fuel tanks

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**Operational and Stowage/Transportation Capabilities**

<b>Normal Operations * CH-46 Equivalents</b>	<b>Stowage/Transport CH-46 Equivalents</b>
LHA 38	Approximately 80
LPH 27	Approximately 70
LPD 6	Approximately 20

\* Normal operation is, as the term suggests, the condition of operating the maximum number of aircraft possible from a ship while adhering to the necessary regulations.

# Appendix E

## Glossary

### Abbreviations and Acronyms

AAA .....	antiaircraft artillery	H&HS .....	headquarters and headquarters squadron
AAW .....	antiair warfare	HARM .....	high-speed antiradiation missile
ABF .....	advanced bomb family	Hawk .....	surface-to-air missile system
AGL .....	above ground level	HE .....	high explosive
AGM .....	air-to-ground guided missile	HEAT .....	high explosive antitank
AIM .....	air intercept missile	HMH .....	Marine heavy helicopter squadron
AP .....	armor piercing	HML/A .....	Marine light attack helicopter squadron
APAM .....	antipersonnel/antimaterial	HMM .....	Marine medium helicopter squadron
APERS .....	antipersonnel	HOGES .....	hover out of ground effect
ARBS .....	angle rate bombing system	HPIR .....	high power illuminator radar
ARS .....	advanced rocket system	HQ .....	headquarters
ASRT .....	air support radar team	HSS .....	helmet sight subsystem
ATARS .....	advanced tactical airborne reconnaissance system		
		IFF .....	identification friend or foe
BLU .....	bomb unit live	IR .....	infrared radiation
		ITOW .....	improved TOW
CBU .....	cluster bomb unit		
CCG .....	computer control group	JMEM .....	Joint Munitions Effectiveness Manual
CEP .....	circular error probable		
		LAAD .....	low altitude air defense
DASC .....	direct air support center	LAAM .....	light antiaircraft missile
		LAU .....	launching mechanism, aircraft installed, unit
FAE .....	fuel air explosive	LRD .....	laser rangefinder/designator
FIU .....	force imagery interpretation unit	LUU .....	lumination unit
FLIR .....	forward looking infrared		
FP .....	firing point	MACG .....	Marine air control group
Frag .....	fragmentary	MACS .....	Marine air control squadron
FY .....	fiscal year	MAG .....	Marine aircraft group
		MAGTF .....	Marine Air-Ground Task Force
GAU .....	gun aircraft unit	MALS .....	Marine aviation logistics squadron
GBU .....	guided bomb unit	MASS .....	Marine air support squadron
GP .....	general purpose		
GPU .....	gun pod unit		



MATCS.....	Marine air traffic control squadron	Stinger.....	man-portable air defense missile system
MAW.....	Marine aircraft wing	SUU.....	suspension unit universal
MSL.....	mean sea level		
MTACS.....	Marine tactical air command squadron	TERF.....	terrain flight
MWCS.....	Marine wing communications squadron	TOW.....	tube launched, optically tracked, wire command link, guided missile system
MWHS.....	Marine wing headquarters squadron	TRAM.....	target recognition and attack multisensor
MWSG.....	Marine wing support group	TRAP.....	tactical recovery of aircraft and personnel
MWSS.....	Marine wing support squadron	TSU.....	telescope sight unit
MWWU.....	Marine wing weapons unit		
nmi.....	nautical mile	VMA.....	Marine attack squadron
NVG.....	night vision goggles	VMA(AW).....	Marine attack (all weather) squadron
OAS.....	offensive air support	VMAQ.....	Marine tactical electronic warfare squadron
PAA.....	primary aircraft authorization	VMC.....	visual meteorological condition
RABFAC.....	radar beacon forward air controller	VMFA.....	Marine fighter attack squadron
RF.....	radio frequency	VMFA(AW).....	Marine fighter attack (all weather) squadron
rpm.....	rounds per minute	VMGR.....	Marine aerial refueler transport squadron
SAM.....	surface-to-air missile	VMO.....	Marine observation squadron
SLEP.....	service life extension program	V/STOL.....	vertical/short takeoff and landing
SSCT.....	special security communications team	VTOL.....	vertical takeoff and landing